
PUTTING THE R IN HART

A LIGHT RAIL PLAN FOR TAMPA

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CHAPTER ONE

RESEARCH PURPOSE

The questions addressed in this research project are:

What would a comprehensive light rail system for the Tampa area look like?

What are possible funding sources for new transit system?

How could zoning be changed to foster transit ridership?

The objectives of this study include:

- To discover connections within the city and surrounding areas
- To locate stations and corridors for which the light rail would operate
- To identify potential funding sources for the system
- To recommend changes and adaptations to the build environment and zoning

Tampa has a growing population and current development patterns indicate willingness of the market to re-densify the City. However, the City is predominately automobile orientated and lacks desirable alternative transportation options. Tampa is ranked 20th in the country for annual delay per traveler and 47.8% of daily travel is in congested areas (Schrank and Lomax, 2007). There currently exist limited bus and commuter bus services and novelty trolley bus and streetcar routes. These options do not adequately address the City's transportation needs due to mode preference, accessibility, and destinations. To solve these issues, the City's leaders are committed to creating a regional mass transit system consisting of both rail and enhanced bus and have recently made this issue one of the mayor's strategic goals.

CONTEXT

PREVIOUS STUDIES

Passenger rail first began in Tampa in 1885, when Henry B. Plant extended his rail network to Tampa. This extension expanded tourism to the Tampa area, providing the first real tourism industry in the region. Thirty years later, local rail transit was introduced to the City. Streetcars survived until the mid-1950s, before they were removed to increase automobile mobility. **Error! Reference source not found.** shows a postcard image of what Franklin Street in Downtown Tampa looked like in the early 1920s. Later, in early 1990s, the Tampa International Airport constructed its own monorail system from the main building to each terminal. These monorails are still in existence and provide an excellent segway into a citywide system.

In the late 1990s, Hillsborough Area Regional Transit (HART) authorized the initiation of 30% design for a streetcar project. This resulted in the creation of the TECO Line Streetcar System, a historic streetcar route operated by a partnership between HART and Tampa Historic Streetcar, Inc. Hillsborough Area Regional Transit (HART) is the transit authority for the Hillsborough County, including the City of Tampa. It operates bus, commuter bus, and in-town trolley services. There are around 35 bus, 17 commuter bus, and two in-town trolley routes. Hillsborough County has 886 transit service miles, compared to over 2,000 transit miles for Atlanta or Minneapolis (Chiaramonte, 2007). HARTline bus is the regional provider of mass transportation and had a total ridership for 2006 of 10,697,621 (Hillsborough Area Regional Transit, 2006). Ridership has been increasing recently and may be due to the inclusion

of the HARTline system in Google Transit applications, which allows easier access to route and scheduling information. The TECO Line Streetcar System, which opened in 2002, considers itself a “Tampa attraction,” part transportation, economic development tool, and entertainment (TECO, 2006). The TECO Streetcar currently has one, 2.3 mile route connecting downtown Tampa to the Channelside district to Ybor City. Operating costs are estimated to be \$1.3 million annually. Farebox revenues have been increasing, but total boardings decreased 10 percent from 2005 to 2006. Average daily ridership is around 1,082 (TECO, 2006).

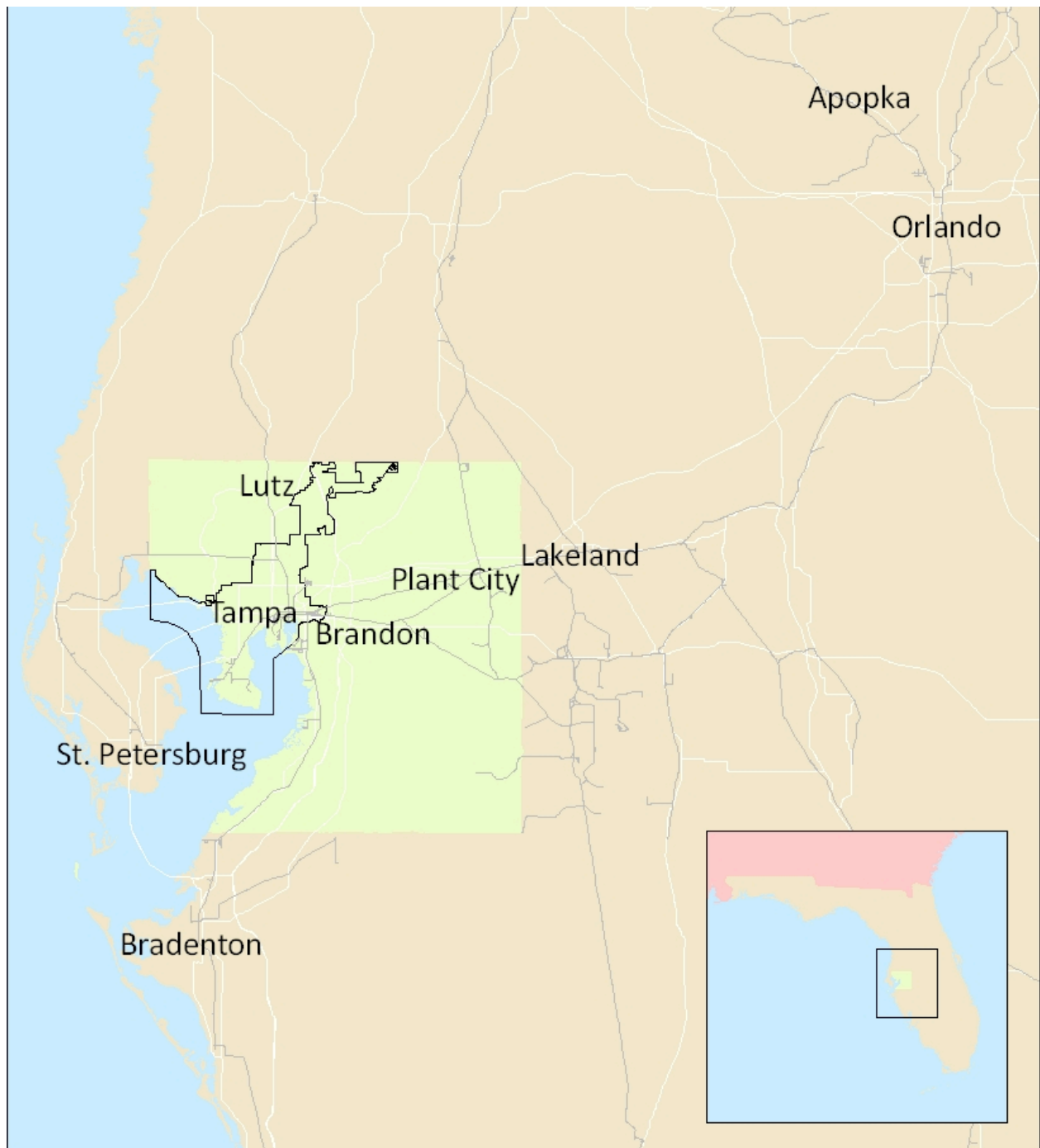
FIGURE 1 DOWNTOWN TAMPA WITH STREETCAR



Source: Wikimedia, 2007

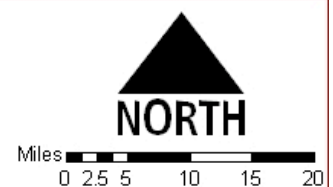
Plans have been proposed for commuter rail and bus rapid transit (BRT). Both of these options would operate primarily on the periphery of the city and predominately address commuter needs, with a lack of non-employment destinations being served. A preliminary plan for light rail has been identified, but it also does not seem to meet the needs of the city. The proposed system serves mainly the eastern part of the City, and does not connect important destinations nor the dense residential sections of South Tampa and the growing Northwestern portion of the City. Tampa to Lakeland commuter rail feasibility and mobility studies were conducted in 1993 and 1998. The route would operate on CSX rail lines. However, the state government is currently working towards an agreement with CSX Railroad to reroute freight traffic from Orlando through Lakeland and Tampa. This additional traffic would negatively affect Tampa's attempt of using the same railways for commuter rail given that CSX would have priority on these corridors (Townsend, 2007). See Figure 2 for reference map. In May 2007, a BRT study for the County was released (Tindale-Oliver, 2007). The study identified four corridors with three alternatives each for as a preliminary conceptual feasibility assessment. The majority of these routes would serve commuter needs on the fringes of the city. To identify and evaluate corridor alternatives, land use, population, demographic, roadway, and activity center data was utilized. A density threshold assessment was conducted for the area. The limitations to this study include addressing the need to connect non-employment center areas and the need for the central city to be linked. The Hillsborough County Board of County Commissioners created a Transportation Task Force in December 1996 to address the needs of the declining transportation system. In August 2007, Hillsborough County's Transportation Task Force published their report titled "Guiding Principles, Strategy and Recommendations." The Transportation Task Force (2007) named congestion mitigation a great priority and concluded that light rail should be implemented for longer term solutions to the congestion problem. In 2002, a final Environmental Impact Statement was released for a proposed rail project (BRW, 2002). The locally preferred alternative was an "L" shaped line connecting the University

FIGURE 2 WEST-CENTRAL FLORIDA



WEST-CENTRAL FLORIDA

- Railroads
- Tampa city limits
- Highways
- Hillsborough County



of South Florida to Downtown Tampa to the Westshore business district. This alternative relied heavily on the usage of CSX right-of-way. Rail capital costs were estimated to be just under \$1 billion (BRW, 2002). Further BRW, Inc. (2002) concluded that the LPA would have little impact on traffic congestion, even near the rail corridor. The plan fails to address the needs of not only the poorest communities in the city, but also the needs of the majority of the city. A more comprehensive transit system must be proposed if Tampa truly wants to reduce their dependence on automobiles and create a sustainable transit system.

NEED

In late 2006, eight focus group public workshops were conducted throughout Hillsborough County. These meetings were designed to explore deeply held values of residents and to explore choices for future transit technologies. Residents expressed that personal integrity, freedom, community, safety, the environment, culture, history, and equity were values that they valued and held in esteem (Hillsborough County MPO Transit Study, 2007). Residents desired more time with family and friends, more reliable travel times, open space, and more accessible goods and jobs. Specifically:

- In Brandon, residents wanted to maintain a rural/suburban feel while creating better transit choices. Residents were frustrated over motor vehicle traffic and congestion. Transit was wanted to link commuters to downtown jobs.
- In Lutz, residents wanted to increase the accessibility and convenience of retail and services to residential neighborhoods. Residents had concerns about adequate space for wildlife habitat. Lutz residents wanted greater transportation options that were more reliable, more frequent, served more destinations, and had better shelters.
- In West Tampa, residents stressed the importance of a diverse and equitable community. Residents wanted increased opportunities and choice for low income, elderly, and youth residents. More efficient, safe, and convenient transportation was desired. Residents also desired lifestyle corridors and village scaled neighborhoods.
- In Temple Terrace, residents desired and easier to use transportation system, with more bike and pedestrian access. They also wanted services to be accessible and to have smart planning and development. Emphasize was placed on improving quality of life and urban form. Residents wanted more reliable and predictable travel times, better accessibility for the disabled and the elderly, better linkages with USF, and a 30-minute threshold for work trips.
- In SouthShore, the environment was considered a top concern. Open space, wildlife preservation, and growth management were valued. Air quality and reduced travel times were transportation concerns. Transit oriented development along major transit corridors and infill development were mentioned desired future development patterns. Residents wanted to increase densities to justify and pay for transit. They also desired a rail system with connections to Bradenton and Sarasota.
- In Town & Country, discussions focused heavily on congestion, travel times, and the need for increased transportation alternatives. The residents desired better transit service hours and frequencies, and high-occupancy vehicle lanes.
- In East Tampa, residents focused mainly on safety with emphasis on more sidewalks and bike paths, more lighting, visibility, security, and times to cross streets. The residents wanted more services and job and better transit serving local and regional destinations.
- In Plant City, residents discussed the preservation of the natural environment through more open space, better connections, and pollution reduction. Residents desired a more walkable and bikeable city with better transportation options and connections throughout the city and the region.

Trends show that Hillsborough County is growing by about 1,900 new residents per month. The Hillsborough County MPO projects that by 2050 the number of new county residents will roughly match the population of Atlanta, Houston, or Dallas. The Tampa Bay region's population is also projected to increase to over seven million residents by 2050 (Hillsborough County MPO Transit Study, 2007). Tampa ranks third in cities with populations over 250,000 for growth of daytime population due to commuters (Iorio, 2006).

From the workshops described above, general consensus is that the current bus system is inadequate. According to the MPO's 2025 Long Range Transportation Plan, the best service bus route in City has a frequency LOS D, an hours of service LOS C, and a travel time LOS of C. Over 60 percent of the bus routes in Tampa, have a frequency LOS of D or E, an hours LOS of C, D, or E, and a travel time LOS of C, D, E, or F (MPO, 2007). Bus service is not frequent enough, is not reliable enough, and cannot serve destinations in a timely manner. Therefore, something more is needed if Tampa wants to reduce congestion, improve mobility, increase environmental sustainability and offer mode choices.

POLITICAL ENVIRONMENT

The Mayor of Tampa, Pam Iorio, is a big supporter of transit in the Tampa Bay area. She has set five strategic goals for herself in office. One of these goals is making regional mass transit a reality. Specifically, the goal states (City of Tampa, 2008):

"The City of Tampa will work on a regional basis to create a mass transit system consisting of both rail and enhanced bus service to serve future generations."

To help meet this goal, the City hired a Transit Manager in 2007. The Mayor also represents the City of Tampa on the Tampa Bay Regional Transit Authority (TBARTA). TBARTA was established by the Florida Legislature in July 2007 to plan transportation networks for a seven county region, which includes Hillsborough County. In November 2007, the Mayor held a series of mass transit information workshops to discuss the role of elected officials, mass transit funding initiatives, regional approaches to meeting the transportation needs. Another workshop series is slated for April 2008. Thankfully, the Mayor sees the correlation between the increased number of beltways and expressways and the increase in commuting time with the decrease of quality of life (Iorio, 2006). Mayor Iorio would like to increase the transportation options in the area. She sees rail as providing a congestion proof and high capacity solution. However, she advocated for the use of CSXT lines for the transit system. Due to the rerouting of freight traffic, this possibility seems very unlikely to occur.

Despite the feelings of the Mayor, some politicians are not willing to support new transit. In the past, Hillsborough County Commissioners have refused to ask voters to pay for new rail plans, despite the plans being federally approved. Additionally, at least one County Administrator has said that she does not believe that local citizens do not want rail transit (Tampa Tribune, 2008).

A decade ago, Charlotte, North Carolina and Tampa were at the same stage in planning. In Charlotte, a new light system opened in November 2007 to massive crowds. The average weekday ridership has been about 14,000 since opening (Charlotte Business Journal, 2008). Tampa could have this same type of success if more political leaders would support improved transit for the region.

CHAPTER TWO

LIGHT RAIL VS. BUS RAPID TRANSIT

Selecting the correct mode for a new transit project is vital to the project's success. Vital to selecting the transit mode is defining the goal of the transit system. The modal choice for a system that is aimed at reducing congestion may be a different modal choice that is created to give basic mobility to persons without access to an automobile.

Light rail refers to a rail transit system that has relatively light traffic capacity compared to heavy rail (traditionally associated with underground subway systems and commuter rail). Light rail operates on shared or exclusive right of ways using lightweight passenger rail cars. Table 1 shows different types of LRT applications. Platform loading can be high or low. Overhead electric lines typically power light rail systems. However, systems in Ottawa, Canada and New Jersey are powered through diesel (Kong, *et al.*, 2008).

TABLE 1 TYPE OF LRT APPLICATIONS

APPLICATION	DESCRIPTION
Exclusive grade-separated rights-of-way	LRT is places on elevated viaducts or in tunnels in certain segments of the system.
Exclusive laterally separated rights-of-way	Placing LRT systems in under-used rail corridors. Crashes can be a major issue if LRT is located near freight lines. USDOT requires physical separation between LRT and freight.
Pedestrian mall transit	Electric-powered LRT cars operate in areas with high levels of pedestrian traffic in downtown or heavily commercial districts
Along a center median	Placing the LRT line in a large street where there is a wide median is possible. Cross-street traffic is often as issue.
Preferential on-street alignment	Places LRT line within a wide street, but with tracks physically separated from motor vehicles by use of different surface treatment, curbs, barriers, etc.
Mixed traffic	Placement of LRT systems in wide streets along with auto traffic for short segments if conditions do not permit separation.

There have been a number of studies comparing the ridership attraction of rail and bus. Rail has been perceived to be more attractive than bus due to factors such as reliability, comfort, and safety. Some of these factors can be eliminated with bus rapid transit. However, light rail may still be more attractive to riders due to the permanence of the infrastructure. Ben-Akiva and Morikawa (2002) specify a number of level of service factors that are generally not accounted for in mode choice models. These include reliability, information availability, comfort, safety from accidents, security from crime, and availability. Reliability issues may become negligible in comparisons of LRT and BRT if the two modes have similar ROW standards, i.e. they are exclusive the same amount of time. Ben-Akiva and Morikawa suggests that rail has the advantage over bus service because the right-of-way is easier to identify and it tends to have higher frequency. Despite the higher quality bus used in BRT and the less frequent stops over traditional, non-exclusive bus, rail is still perceived to be a smoother ride, with more fluid starts and stops than buses can perform. Safety from accidents is perceived to be higher for rail due to the mechanized guidance and control systems. However, safety may be perceived to be higher on buses because every vehicle has a driver. Although

traditional buses may be more available to a greater number of people, rapid transit offers more frequent service (Ben-Akiva, *et al.*, 2002).

Ben-Akiva and Morikawa (2002) compared revealed and stated preference data to obtain mode preference. The revealed preference study was based on data obtained by the Metropolitan Washington Council of Governments. There were eight corridor types and three household categories. The results were that people preferred the Metro the most, followed in order by local bus, express bus, and commuter rail. Of the 24 corridor/household categories examined, the only one that did not follow the above result was the corridor in which at least either origin or destination is in the CBD, metro low frequency line corridor, and HOV lane corridor for zero-car households. Along this corridor, zero-car households preferred express bus, metro, local bus, and then commuter rail. Ben-Akiva, *et al.* also found that the preference bias towards Metro travel over express bus and commuter rail travel increased as car availability increased.

Studies in Sweden conducted on 4,000 commuters by Statistics Sweden examined commuter mode choice between Stockholm and Uppsala, a distance of about 72 km (Johansson, *et al.*, 2006). Trains run every 10 minutes, cost SEK 36, and take 40 minutes. Buses run every 20 minutes, cost SEK 29, and take an hour. 31 percent of respondents commuted by train and 9 percent commuted by bus. Analysis found that the latent factors age, income, gender, presence of children, education, and household tenure were all significant and positive. In addition, women are more environmentally inclined than men. Higher income persons had stronger preferences for convenience and safety preferences decrease with income (Johansson, *et al.*, 2006). Comparing train and bus preference, comfort and environmental concerns were statistically significant. Safety was found to be an insignificant variable.

In the latter half of the 1990s, overall transit ridership grew by 21 percent, with the largest increases in growth attributed to rail passengers (Pucher, 2002). These sentiments have been strengthened by data from the National Transit Data and Nation Household Travel Survey, which indicates a growing share of all transit trips are on rail systems (Polzin, 2003).

Rail service has a physical presence, which allows the public to easily understand service area, unlike in bus systems. Thus, LRT project mature relatively quickly, with subsequent growth driven by system, extent and service levels (Polzin and Page, 2003).

CHAPTER THREE

METHODOLOGY

METHODS

The methods proposed in this study to construct a proposed light rail system will take advantage of spatial analysis and visualization capabilities of Geographic Information Systems (GIS) and alternative comparison capabilities of Analytic Hierarchy Process (AHP). Demographic, transportation, and activity data will be mapped and assessed with the use of built-in GIS tools within the ESRI ArcGIS software. Criteria will be established to determine the most transit-friendly and transit-needing areas. Relative importance of the criteria will be determined and a rating scale will be developed to evaluate alternatives. Then, the AHP method will be used to create a hierarchy of alternatives based on relative importance of the demographic, transportation, and activity data. The AHP method will be integrated into GIS to establish the highest valued alternatives. Phasing of the system will also use the results of the AHP method.

Guidelines previously established for other communities such as those in Seattle and Central Florida will be consulted for potential improvements to the built environment. Multimodal Transportation District (MMTD) legislation will guide the process and potential sites for MMTD designations will be identified.

Capital costs will be determined through the use of FTA cost guidelines. Funding sources will be identified through financial reports of the City of Tampa and the Florida Department of Transportation, case studies of newly formed light rail systems, and recent literature on the subject.

DATA

To create the plan, data available from the United States Census 2000, the City of Tampa, and ESRI will be used. Table 2 shows the data from the Census that will be examined at the block group or block level:

TABLE 2 CENSUS DATA

DATA DESCRIPTION
Population
Race
Median Household Income
Poverty Status
Sex by Age
Households
Average Household Size
Educational Attainment
Tenure by Vehicle Available
Aggregate Number of Vehicles Available
Group Quarters Populations
Marital Status
Sex by Earnings

Population identifies areas that will provide the highest potential ridership. Median income and poverty level data are included to ensure that populations who may not be served by other areas of the market can be captured. Median age will identify block groups that have a high elderly population and may be more in need of transit services. However, results from passenger ridership surveys in Chicago and Portland indicate that young, well educated, middle income individuals also represent a well-represented ridership demographic (Horner and Grubestic, 2001).

Thus, it is important to include indicators of this market. The limitations of using Census data from 2000 is that it may be outdated. However, this is the general practice in the transportation industry.

Economic Census data will be used to locate areas of high retail and employment activities. City of Tampa data will include roadway level of service (LOS), average annual daily traffic (AADT), and land use. These data sets will help identify corridors that are nearing capacity and/or corridors that have high volumes, offering high potential for mode share transfer. This data is publically available on-line. ESRI data will include street maps and will be used to identify street centerlines.

LITERATURE REVIEW

GIS APPLICATIONS IN TRANSIT PLANNING

One of the most significant potential uses of Geographic Information Systems (GIS) is transit planning - mainly, service planning, ridership forecasts, accessibility analysis, and market analysis. Sutton (2005) states that the transit industry applies GIS to new rail starts analysis and that one of the largest growth areas of GIS in transportation is service planning. Studies have indicated that GIS can be used in the creation of transit networks. Spatial analysis and dynamic segmentation tools performed on street network data were used to locate potential corridors and stop locations (Choi *et al.*, 2000). The network was then algorithmically created from stop and route information. Choi *et al.* (2000) concluded that GIS-oriented approaches to create transit networks were vastly superior to conventional analog mapping with text editors. Horner and Grubestic (2001) showed that a GIS-based approach could be used to locate urban rail terminals and park and ride lots. To obtain locations, accessibility and network-based drive times were used. Market characteristics of census block group were estimated using a series of variables for workforce characteristics. Standard overlay operations were used to locate and value the demand within each park-and-ride candidate's commutershed given network and market data. Raster data containing geographical and spatial information have been spatially analyzed in GIS to solve bus routing problems (Dantas *et al.*, 2001). These same techniques can also be applied to light rail problems.

Transit agencies use census data for service planning and to determine the service area characteristics of a transit network (Catala, 2003). In a study of Florida transit agencies, 37% of those reporting in 2002 stored data in census tract boundary files and 36% used demographic data with their GIS (Catala, 2003). Census data used at Florida transit agencies were identified to be: Total Population; Hispanic or Latino by Race; Sex by Age; Place of Work – State and County Level, Place Level, MSA Level; Means of Transportation to Work; Travel Time to Work; Travel Time to Work by Means of Transportation; Sex by School Enrollment; Sex by Educational Attainment; Sex by Employment Status; Family Type by Number of Workers in Family; Sex by Industry; Household Income; Median Household Income; Poverty Status; Tenure by Vehicles Available; Aggregate Number of Vehicles Available (Catala, 2003). In surveys conducted in 2002 and 2003, respondents commented that GIS benefited their organizations by improved service through matching transit service with demographic data (Sutton, 2005). The connection between employment and public transportation using census data and GIS has been explored for Atlanta, Georgia and Portland, Oregon (Sanchez, 1999). This study reveals that average rates of labor participation can be determined by access to public transit.

ANALYTIC HIERARCHY PROCESS

Analytic hierarchy process (AHP) is a methodology that is useful in defining a characteristically multilayered public transportation problem. It has been used to assess light rail transit corridor and route alternatives (Banai, 2006). GIS and AHP have been integrated to solve bus routing problems (Dantas *et al.*, 2001). GIS-AHP integration reduces the amount of data collection and can be accomplished with low expertise in either field. Dantas *et al.* (2001) divided GIS-AHP integration into four phases: intelligence, design 1, design 2, and choice. These phases describe the problem, identify criteria, compare alternatives, prioritize alternatives, and decide on a plan. The steps were followed to define a circular bus route for Sobradinho, Brazil. Banai (2006) showed how the AHP procedure could be used to facilitate the public transportation decision-making process and help guide the public transportation project through the New Starts process.

ADAPTING THE BUILT ENVIRONMENT

One of the most difficult challenges in creating a fixed guideway transit network is adapting the established built environment. Reports have suggested several approaches such as focusing transit oriented development (TOD) around park-and-ride lots, changing land development regulations, offering development incentives, predesignating transit corridors, and adapting transit service to the needs of suburban-style communities (Hendricks and Goodwill, 2002). In Hendricks and Goodwill (2002), five case studies were presented illustrating the adaptation of the built environment to new transit projects. The report focused on how older, established communities have retrofitted land development practices to encourage the use of alternative modes of transportation. This is primarily done through reestablishing transit orientation and allowing safe and convenient access to transit service.

Zoning must also be changed to allow for greater densities. Necessary zoning changes include the amendment of maximum floor area ratio, height limitations, minimum setbacks, landscaping requirements, lot coverage maximums, segregation of land uses, and minimum parking requirements (Hendricks and Goodwill, 2002). Hendricks and Goodwill (2002) state that parking and access management is an important component of adapting development to support transit use. Shared parking, lower parking-to-occupant ratios, on-street parking, and parking behind buildings are design approaches that can be taken to manage access.

Zoning overlays and trip reduction ordinances are two more ways municipalities can change zoning to promote transit use (Hendricks and Goodwill, 2002). Zoning overlays apply provisions to specific areas within a basic use zoning district. This has been done in Seattle to promote the development of future light rail stations. In 2001, Seattle passed Station Area Overlay legislation aiming to encourage housing development and discourage automobile oriented development around eight future light rail stations (City of Seattle, 2001). Trip reduction ordinances are a transportation management strategy that requires developers, property owners and/or employers assist in funding and promotion. These ordinances may only be applied during peak periods, may be established from standardized trip generation rates, or may establish penalties for noncompliance (Center for Urban Transportation Research, 1996). Crafting transit supportive design guidelines has also been identified as a proactive approach to encourage transit considerations in future development plans (Hendricks and Goodwill, 2002). Snohomish County in Washington and the Central Florida Regional Transportation Authority both use design manuals that visually present what types of design should be promoted.

In 1999, the Florida legislature enabled local governments to establish Multimodal Transportation Districts (MMTD), which allows for the development of multimodal environments within urban areas (Williams *et al.*, 2004). MMTD serve to reduce vehicular usage by including mixed-use activity centers, connectivity of streets and land uses, accessibility to alternative modes of transportation, and incorporating transit-friendly design features. Local governments are encouraged to offer incentives to promote development with MMTD. Williams *et al.* (2004) state twenty policies have been identified for implementation in order to ensure compliance with MMTD legislation. The policies include designation criteria, transportation quality, relation to major arterials, transportation concurrency, bicycle/pedestrian network and connectivity, transit, consideration for demographics, parking reduction, building orientation, and design guidelines.

CHAPTER FOUR

SYSTEM DESIGN

The transit network that was developed in this paper used AHP and spatial and network analysis tools built into the ArcGIS software. The AHP was used to help select transit supportive areas and route phasing. Spatial and network tools in GIS determined stations locations and route systems.

STATION LOCATIONS

Six criteria were used to determine the best LRT station locations: population density, employment density, transit dependant populations, choice rider populations, locations with high poverty, and locations with high older citizen populations. The relative importance of the criteria was determined through the paired comparison method of AHP in conjunction with the nine-point numerical scale of AHP. The nine-point system is defined as: equal importance, when two activities contribute equally to the objective (1); moderate importance of one over another (3); essential or strong importance (5); very strong importance (7); extreme importance (9) (Banai, 2006). There are intermediate values between judgments.

Population density was determined to be a significant in selecting station locations because high densities provide transit systems with the ridership necessary to be successful. Employment density was determined to be significant as City leaders cite the traffic from commuters as a main contributing factor to the desire for new transit systems. Literature has been proven to a significant determinant of ridership not only at the metropolitan level, but also at the station-area level (Rosenbloom and Clifton, 1996; Parsons Brinckerhoff Quade & Douglas, Inc., 1996). Cervero (1993) found that station-area residents are 5 to 7 times more likely to travel by rail than non-station area residents.

Choice rider populations were considered a priority because these are populations that traditionally don't use transit, but may switch modes given premium service, such as with light rail. Choice riders are usually wealthier individuals and households. Several studies have confirmed that the percentage of people using rail modes increase with income and that wealthier commuters are more likely to use rail over bus (Rosenbloom and Clifton, 1996; Wachs, *et al.*, 1993; Wachs and Taylor, 1998).

Transit dependant populations were chosen as a criterion because they are the most needy of the system and will provide a baseline ridership. In addition, as the City strives to make a more equitable transit system, is important to consider the needs of the City's transit dependant. This line of reasoning can be extended to locations with high poverty levels. Fixed guideway transit investment has been shown in the literature to increase property values and stimulate economic development. Both of these aspects are needed the most in areas with high poverty levels. Additionally, with more connections to areas that may provide increased capital gain, a reliable rapid transit system may be able to strengthen the economic aspects of those in poverty. Older citizen were considered important in the determination of stations for the Tampa light rail because as Florida as a high percentage of senior citizens, there is more of a necessity to provide them with transportation options as senior drivers have increased risk for accidents and endangerment on the road. Senior citizens may find bus service intimidating and may find permanent guideway transit more accommodating and friendly. Further, older Americans are expected to outnumber younger Americans by 2050, therefore it is important to incorporate the needs of older Americans in planning exercises (Reconnecting America, 2007).

Table 3 shows the relative importance of criteria and the respective weights for each criterion. Areas with high population density were considered to be near moderately more important than stations with high employment density and transit dependant populations, moderately more important than stations with high choice ridership locations, and strongly more important than locations with high senior populations. Employment density was considered to be near moderately more important than transit dependant and choice rider populations, moderately more important than

areas with large populations in poverty, and near strong importance to senior populations. Weights were found by squaring the 6x6 matrix and normalizing the eigenvectors for the squared matrix until stabilized. This method is known as the Eigenvalue Method described by Saaty (1994). Stabilization occurred after four iterations. The inconsistency of importance was found to be 0.02.

TABLE 3 RELATIVE IMPORTANCE OF CRITERIA WITH RESPECT TO BEST STATION LOCATIONS

	POPULATION	EMPLOYMENT	TRANSIT DEPENDANT	CHOICE RIDERS	POVERTY	>65 YEARS OLD
POPULATION	1	2	2	3	3	7
EMPLOYMENT	1/2	1	2	2	3	6
TRANSIT DEPENDANT	1/2	1/2	1	1	2	5
CHOICE RIDERS	1/3	1/2	1	1	2	5
POVERTY	1/3	1/3	1/2	1/2	1	3
>65 YEARS OLD	1/7	1/6	1/2	1/5	1/3	1
WEIGHT	0.339	0.242	0.153	0.144	0.087	0.035

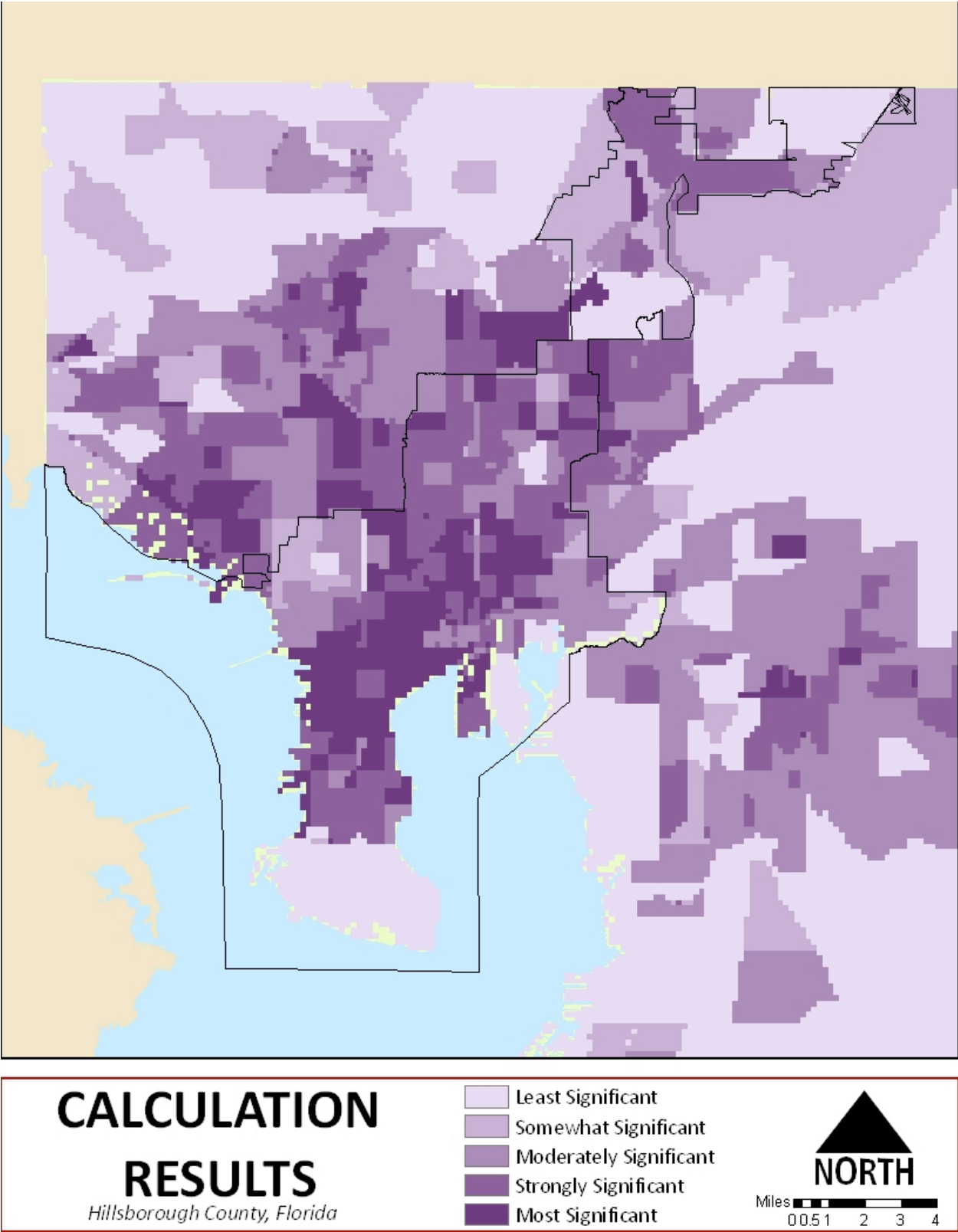
Population density was measured in the estimated 2025 population per square mile taken from County TAZ data. Employment density was measured in the estimated 2025 employees per square mile taken from County TAZ data. Data estimated for 2025 was used for its long-term planning advantage. Poverty densities were found using poverty levels at the block group level found in the Census 2000 Summary File 3. Older than 65 population densities were found using age levels at the block group level in the Census 2000 Summary File 1.

Transit dependant populations were found by taking the block group population from the 2000 Census and finding the number of residents over the age of 16. Then, the population by group quarter was found for the block group. The population by group quarter was subtracted from the population over the age of 16 to obtain the number of eligible drivers in each block group. The aggregate number of automobiles available for each block group was found from the Census 2000 Summary File 3. To find the number of transit dependant individuals, the aggregate number of automobiles was subtracted from the number of eligible drivers. This was the simplest method to finding transit dependant populations in the literature. However, this method has drawbacks. Namely, if a Census block group has a large amount of higher income households who may have more automobiles than residents over 16, transit dependant populations may not be identified.

The definition of choice riders are those riders who have automobile access, but choose to take transit. There is a lack of literature on how to define the characteristics of these riders. For the purposes of this paper, choice riders were defined as populations who were 25 to 40 years of age, single with no children, college educated, and making over \$50,000 a year. The percentage of each of these characteristics were found for each Census block and then multiplied together to find the minimum number of people who fit this criterion. This method was used due to the lack of the ability to cross-tabulate Census data. However, the obvious limitations are the under-representation of choice rider populations.

After collecting all the necessary data, the attributes of Census data were joined to the respective TAZ or block group GIS files. The joined GIS files were then converted to raster files and reclassified into a rating scale. Then, the Raster Calculator function in ArcGIS was used to establish those areas with highest priority for station locations by multiplying the reclassified raster files by the criteria weights and scaled. Figure 3 shows the results of the Raster

FIGURE 3 RASTER CALCULATION RESULTS



Calculation. The equation used for the Raster Calculation was, with fractions in the equation representing the scaling factors to ensure each attribute was on a zero to one scale prior to multiplying by the criteria weights:

$$(\frac{1}{2})(0.339)[\text{population density}] + (\frac{1}{2})(0.242)[\text{employment density}] + (\frac{1}{3})(0.153)[\text{transit dependant}] + (0.144)[\text{choice riders}] + (\frac{1}{3})(0.087)[\text{poverty}] + (\frac{1}{3})(0.035)[\text{older populations}]$$

However, some locations that were considered to have high destination desirability may not be easily identified through the method described above. However, these locations may be vital to the success of any transit system in the region. Table 4 shows the places of high interest to residents and to tourists. These preliminary stops include five transfer spots to other modes of transit in the region to increase mobility and regional connectedness. Figure 4 shows a combination map of potential station areas and places of interest.

TABLE 4 PLACES OF INTEREST

PLACE OF INTEREST	TYPE
Busch Gardens & Adventure Island	Theme Parks
Citrus Park Town Center	Mall
Florida Aquarium	Aquarium
Florida State Fairgrounds	Fairgrounds
Hillsborough Community College	Colleges & Universities
International Plaza	Mall
James A. Haley Veterans' Hospital	Hospital
John F. Germany Public Library	Library
Legends Field	Sports Venue
Lowry Park Zoo	Zoo
Marion Transit Center	Bus Transfer Center
Museum of Art	Museum
Museum of Science & Industry	Museum
Performing Arts Center	Arts Facility
Raymond James Stadium	Sports Venue
St. Joseph's Hospital	Hospital
St. Pete Times Forum	Sports Venue
Tampa Convention Center	Convention Center
Tampa General Hospital	Hospital
Tampa Greyhound Station	Greyhound Station
Tampa International Airport	Airport
TECO Streetcar System	Streetcar Station
Union Station	Amtrak Station
University Community Hospital	Hospital
University of South Florida	Colleges & Universities
University of Tampa	Colleges & Universities

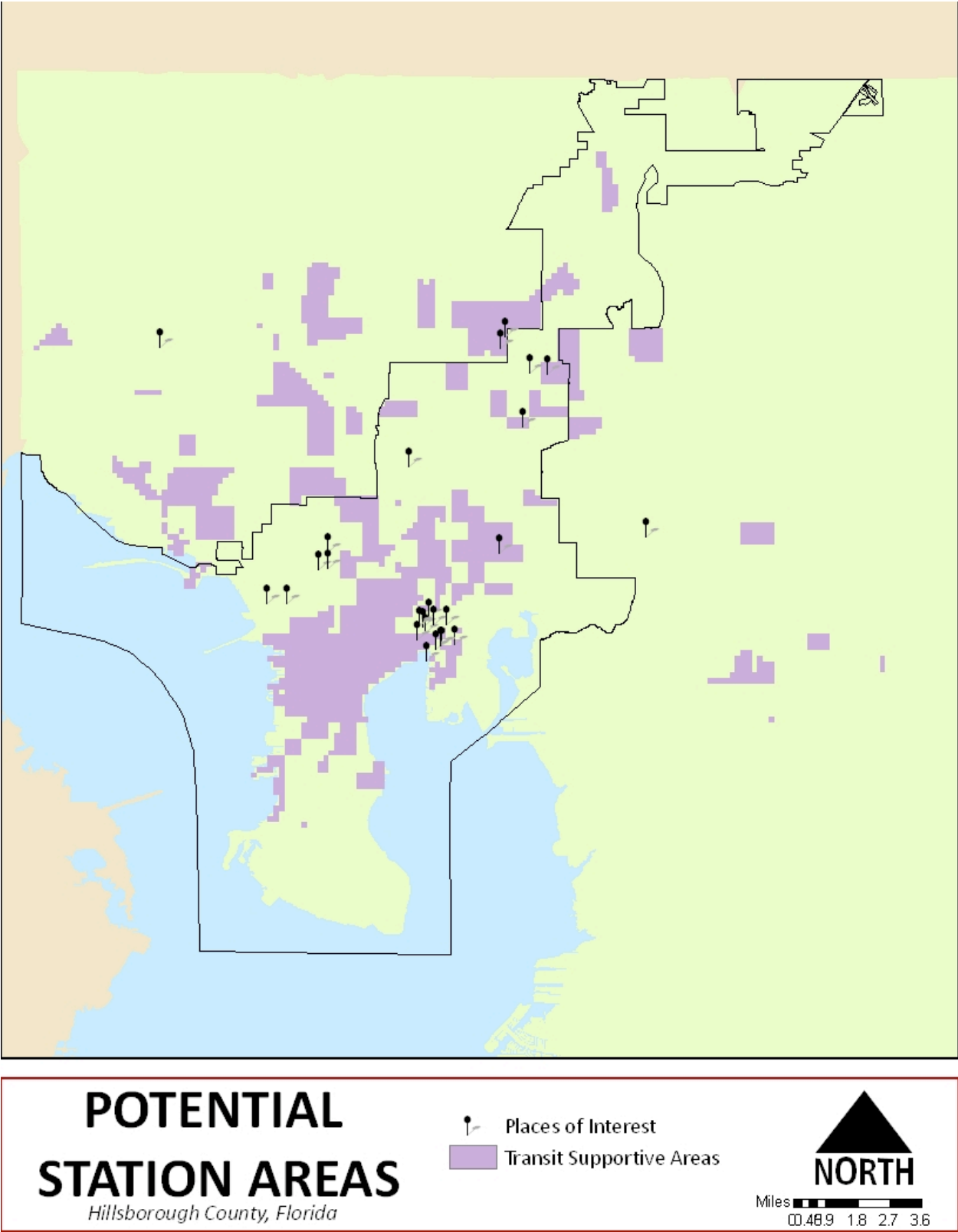
Final station locations were determined through examining the results of the Raster Calculation and destination locations. Further stations will be included when routes are identified, to increase access to the system.

ROUTE SELECTION

Based on the comments gather by Hillsborough County and the City of Tampa, the following connections were considered in the system design:

- Brandon and Downtown Tampa
- Temple Terrace and the University of South Florida (USF)
- Plant City and Tampa

FIGURE 4 POTENTIAL STATION LOCATIONS



- Area south of Gandy Boulevard and Downtown Tampa

However, some of these connections may not be suitable for a light rail system due to distance if there are not enough intermediate transit stop locations. After plotting preliminary station locations, it was determined that there were not enough preliminary station locations from Downtown Tampa to Brandon and Plant City. Therefore, these routes will most likely be better served with either express bus or commuter rail primarily due to cost. The area south of Gandy Boulevard may not be able to be connected due to street width restrictions in older sections of town.

Routes were found through network analysis tools within ArcGIS. First, the street network for the area was converted into a network dataset. The station locations were inputted and converted into network locations. Stations were then selected for each route. Routes were solved using the Route tool in the Network Analysis toolbox. This procedure was repeated until the optimal connections were created.

FINAL DESIGN

The final design of the system was comprised of six routes, with an average of 17 stations and an average length of 13.45 miles. The system is composed of four mainly north/south routes, one east/west route, and one circular route. Table shows descriptions of each route, while Figure 5 shows the system map.

TABLE 5 ROUTE DESCRIPTIONS

ROUTE	# OF STATIONS	ROUTE LENGTH	COMMENTS
Dale Mabry/Channelside	24	17.14 miles	North/south route connecting highly populated residential areas with HCC, sports venues, Downtown and Channelside
Citrus Park/Kennedy Blvd.	20	15.84 miles	North/south route connecting regional malls, airport, high residential and employment areas, and Downtown
New Tampa/Downtown	17	17.29 miles	North/south route connecting newer residential areas and high employment areas with USF, regional hospitals, and Downtown
Downtown Loop	11	3.38 miles	Circular route connecting densely populated Harbour Island with Channelside and Downtown, including the Museum of Art, Performing Arts Center, and bus transfer station
USF/Ybor City	14	10.13 miles	North/south route connecting USF, theme parks, and Ybor City Historic District
Northern Connector	15	16.93 miles	East/west route connecting regional mall, large residential areas, theme parks, USF, and employment centers. This route provides easier transfers for residents and employees without needing to connect through Downtown

As shown in Figure 6, this route serves the majority of those areas that were deemed to be transit supportive from the Raster calculation. When compared to the proposed light rail system created by consultants hired by the City, the system in this report provides better overall connections throughout the City, most notably in the Western portion of the City.

FIGURE 5 SYSTEM MAP

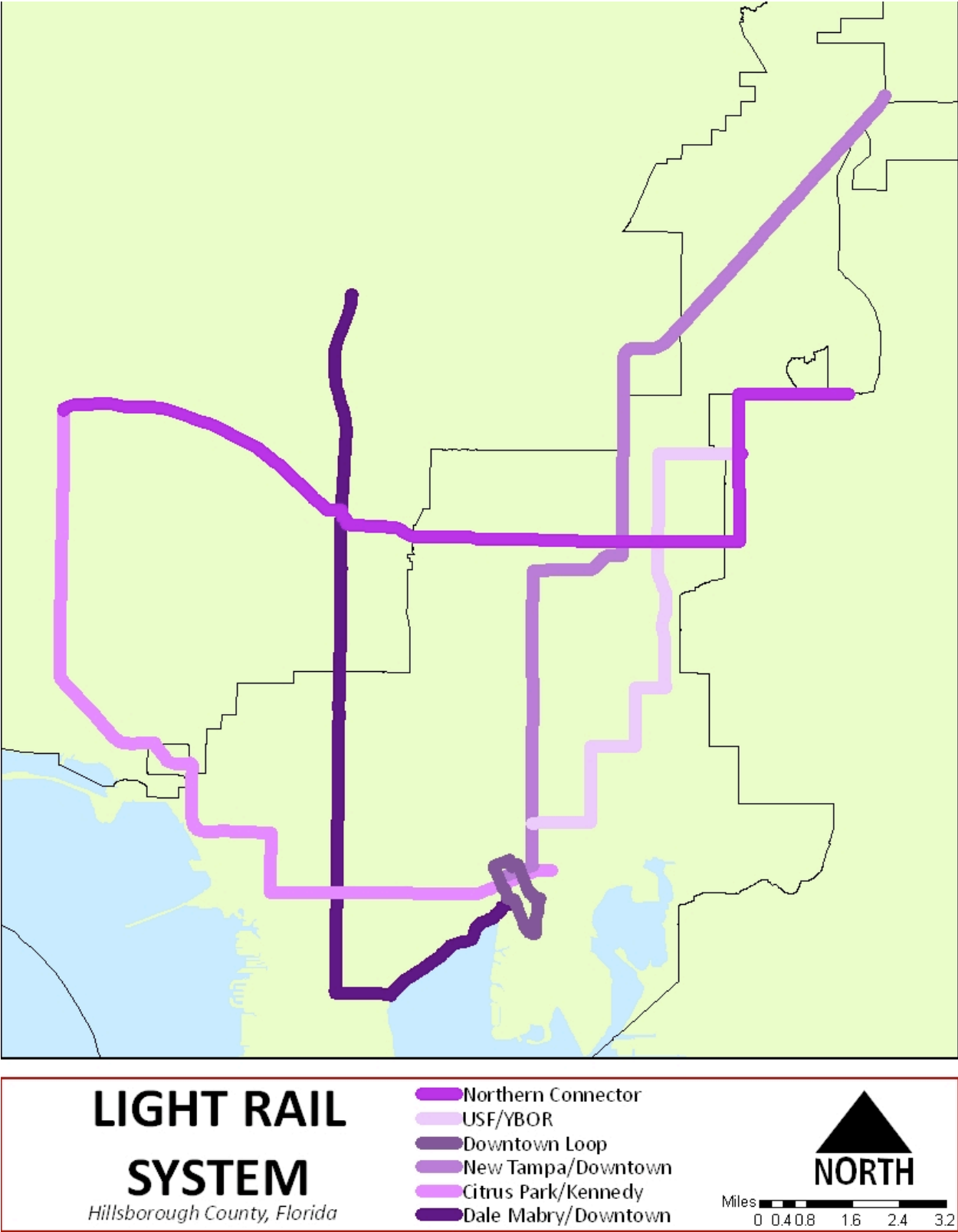
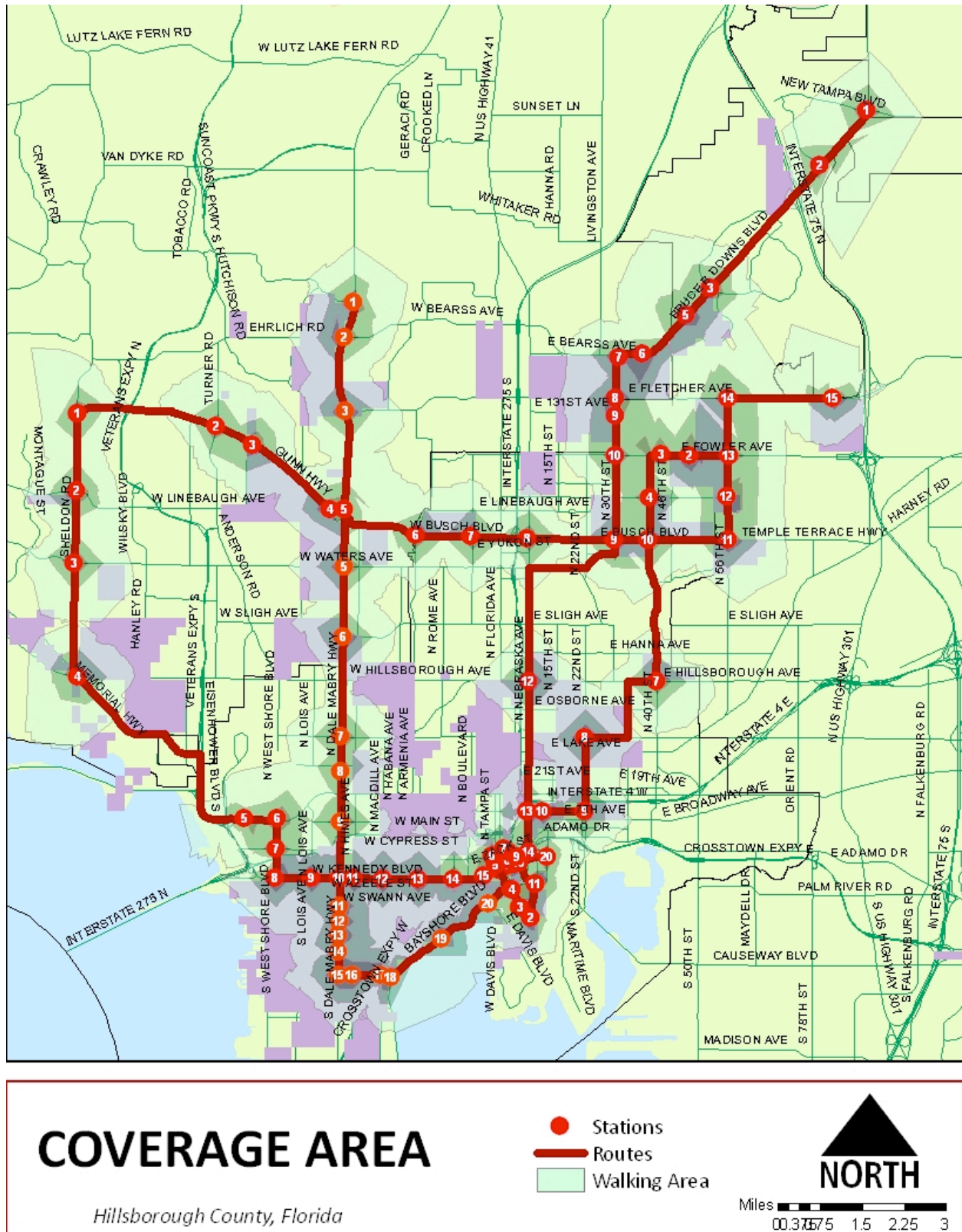


FIGURE 6 SYSTEM COVERAGE



PHASING

The AHP method was again used to determine phasing priority. There were six criteria associated with the phasing process: choice rider population, transit dependant population, ability to become a TOD corridor, mobility, LOS of major roads along corridor, and cost. Weights associated with each criterion were determined using the AHP method described above. Table 6 shows the phasing criteria weights and each station's overall score. Cost is in millions of dollars. Cost was determined by multiplying the length of the corridor by the average cost per mile for a sample of light rail system throughout the nation. See Table 8 for detailed explanation. Overall cost will be lower than the summation of all the routes due to shared rail corridors and stations. See Chapter Five for a more thorough investigation of cost estimation. Scores were normalized to be on a scale of zero to one. The inconsistency of importance was found to be 0.07.

TABLE 6 PHASING CRITERIA

ROUTE	CHOICE RIDERS	TRANSIT DEPENDANT	TOD CORRIDOR	MOBILITY	LOS	COST	SCORE
Dale Mabry/ Channelside	Med	Low	High Potential/ Existant	High	F	\$627	0.226
Citrus Park/ Kennedy	Med	High	Potential/ Existant	High	D	\$580	0.226
New Tampa/ Downtown	Low	High	Potential/ Existant	High	F	\$633	0.247
Downtown Loop	Med	High	Existant	Med	D	\$124	0.077
USF/Ybor City	Low	High	Limited Potential/ Existant	High	F	\$371	0.128
Northern Connector	High	Med	Potential	Med	D	\$620	0.096
Weights	0.185	0.251	0.177	0.189	0.116	0.082	

Thus, according to the AHP method, the lines should be constructed in the following order: New Tampa/Downtown, Dale Mabry/Channelside, Citrus Park/Kennedy Blvd, USF/Ybor City, Northern Connector, Downtown Tampa.

This report proposes that the six-route light rail system be built in two phases. Thus, the Dale Mabry/Channelside, Citrus Park/Kennedy, and New Tampa/Downtown routes should be built first, with the remainder of the routes being built in a timely manner thereafter. This phasing schedule would provide mobility for each region of the city, with increased mobility as preliminary routes and ridership are established. In the first phase, major hospitals, the University, sporting venues, the airport, residential sections, and high-density employment areas would be connected to each other. The second phase would further connect the University, residential, and employment areas, while improving general mobility in the Downtown region.

CHAPTER FIVE

FUNDING

COSTS

A vital initial component of introducing a new light rail system is the cost of physical assets, both fixed and moveable. There are three major categories of costs: capital, operating, and maintenance. Capital cost refers to the construction, expansion, and modification of the physical infrastructure. Operating cost refers to standard operations. Maintenance cost refers to maintaining the system in a satisfactory condition (Kong, *et al.*, 2006).

There are a number of factors that contribute to the capital costs such as design standards, equipment types, climate, terrain, and purchase quantities (Kong, *et al.*, 2008). Although light rail capital costs generally exceed the costs of other modes, light rail typically operate at larger capacities. Thus, light rail often has lower unit operating costs than other modes. Table 7 shows the Federal Transit Administration's nine categories of transit capital costs.

TABLE 7 CATEGORIES OF CAPITAL EXPENDITURE FOR LRT

INFRASTRUCTURE TYPE	DESCRIPTION OF ASSOCIATED EXPENDITURE
Revenue vehicles	Capital costs to acquire, remanufacture, overhaul existing revenue fleet (transit agency vehicles that are used to provide transit service for passengers)
Service vehicles	Costs of acquiring or overhauling service fleet (transit agency vehicles that are not used to provide transit service for passengers)
Passenger stations	Costs of design and engineering, land acquisition, demolition, and purchase or construction of stations
Vehicle maintenance	Costs of design and engineering, land acquisition and relocation, demolition, and purchase or construction of maintenance buildings
Fare revenue collection equipment	Costs of acquiring fare revenue collection equipment
Administration buildings	Costs of design and engineering, land acquisition, and relocations, demolitions and purchases of administration buildings
Systems	Costs of acquiring systems for information and communication
Guideways	Costs for design and engineering, land acquisition and relocation, demolition, and purchase or construction of the guideway
Other	Furniture, shelters, signs, passenger amenities outside of passenger stations, equipment that is not a fundamental part of buildings and structures

Source of original information: Federal Transit Administration. Taken from Kong, *et al.*, 2008.

According to the America Public Transit Association, 85% of all rail transit agencies in the United States had an average cost of new light rail systems between \$2.3 and \$4.25 million/vehicle in 2005 dollars (Cambridge Systematics, Inc., *et al.*, 1992). Costs for light rail fixed facilities can vary based on system size, number of crossings, right-of-way requirements, alignment, and location. Construction costs can be decomposed in the following way: guideway (23%), maintenance yards and shops (5%), systems (10%), stations (5%), vehicles (13%), special conditions (7%), ROW (8%), and “soft” costs (29%) (Kong, *et al.*, 2008).

Costs for guideways can be significantly reduced if existing right-of-way is used due the existence of infrastructure. The range for light rail system capital cost per kilometer has been reported in the literature to be 10-30 million USD (Vuchic, 2007). In the early 1990s, a study of five cities in the United States found that the average cost for maintenance yards and shops was \$0.6 million in 2005 dollars. The range was found to be \$0.14 million to \$1.3 million (Booz-Allen & Hamilton, Inc., 1991). At-grade stations are the least expensive station type to construct. Center platforms cost about \$100,000 per station and side platform stations cost about \$130,000 per station (Cambridge Systematics, Inc., *et al.*, 1992). However, these costs do not include design, engineering, right-of-way acquisition, and other administrative costs.

Some studies have reported costs as an overall system cost per track-mile. Using this method, overall costs ranged from \$12.4 million to \$58.6 million (Kong, *et al.*, 2008). Variations in cost can be attributed to differences in project specifications and site characteristics. Table 8 shows overall costs per mile for various systems throughout the United States.

TABLE 8 SPECIFIC INSTANCES OF LIGHT RAIL OVERALL COST PER MILE

PROJECT	COST/MILE
Baltimore Central Line Phase 1	18.8
Baltimore Central Line – three extensions	16.4
Dallas DART – S&W Oak Cliff	31.3
Dallas DART – Park Lane	58.6
Denver RTD – Central Corridor	24.4
Denver RTD – Southwest Extension	20.3
Los Angeles MTA – Blue Line	43.4
Los Angeles MTA – Green Line	49.0
Portland Tri-Met – Banfield	26.6
Portland Tri-Met – Westside	56.7
Sacramento RTD – Original Line	12.4
Sacramento RTD – Mather Field Road Extension	15.4
Salt Lake City UTA – South Line	21.4
St. Louis MetroLink – Phase 1	20.8
San Diego Trolley – Blue Line	31.3
San Diego – Orange Line	23.5
Santa Clara County (VTA) – Guadalupe Corridor	26.2
Santa Clara County (VTA) – Tasman Corridor	43.8
<i>Average Cost per Mile</i>	<i>36.6</i>

Taken from Kong, *et al.*, 2008.

Using the average \$36.6 million cost/mile, the system in this report, which is 77.33 of total route miles, would cost \$2.784 billion. For the first phase, which consists of 33.33 miles, is estimated to cost \$1.2 billion. The second phase, which consists of the remaining 44 miles, is estimated to cost \$1.61 billion.

The type of light rail guideway is not known, and may include a mixture of at-grade, elevated, or elevated fill guideways. In this type of situation, the following overall capital construction cost model can be used (Sinha and Labi, 2007):

$$TC = \text{EXP}(-1997.92 + 1448.22L^{0.0005} + 553.55ST^{0.0005}),$$

where TC = total cost in millions of dollars, L = system length (miles), and ST = number of stations. This cost model includes guideways stations, and maintenance yards. The system presented in this report is 77.33 miles in length and has 75 stations. Inputting these characteristics into the model above, it is estimated that the proposed system would cost \$3.634 billion, or about \$47 million per mile.

Thus, the cost estimation may be somewhere between \$2.784 and \$3.634 billion for the system in total, with the first phase costing about \$1.2 billion and the second phase costing about \$1.61 billion.

POTENTIAL SOURCES

With recent budget cuts in the State Legislator and at the County level, it is increasingly important to find alternative funding for transit systems that does not rely on subsidy appropriation.

A report for Illinois PIRG has suggested seven principals for funding transit. Each option for funding transit would ideally have the qualities listed below (Imus, *et al.*, 2007):

1. Enhance market efficiency – taxes and fee the help accurately reflect the true cost of driving and developing is preferred because they more accurately reflect societal costs
2. Low collection costs – costs incurred by collecting, monitoring, and enforcing taxes and fees can deplete resources, providing less money for transit
3. Reliability – reliable funding is needed in order to plan long term so that transit can be planned and grow as the population and economy also grows
4. Diverse funding – diverse funding is needed to protect the transit agency from fluctuations in the economy
5. Fare increases are self defeating – increasing fares prices people out of the transit market and make transit use unattractive and undesirable
6. Budget accountability – transit agencies need to be held accountable for funding and service decisions
7. Community participation – funding decisions need to include community participation since the community is the ultimate user and beneficiary

Most funding for transit systems comes from a variety of sources. State legislatures can appropriate operating and capital funds in the yearly budget, use federal transportation funds for transit, and/or dedicate revenue streams from particular funding sources. Funding sources should do more than just raise revenue. They should improve market efficiency by correcting market failures or better allocating costs to those who receive benefits.

The source of funding with the most potential is federal funding through SAFETEA-LU. In July 2005, the U.S. House of Representation and the Senate approved SAFETEA-LU. The bill provides \$286.4 billion, including \$52.6 billion for transit through 2009 (APTA, 2005). With the success of predecessors ISTEA and TEA 21, it seems inevitable the SAFETEA-LU should be reauthorized when funding provisions expire. SAFETEA-LU provides funding for the New Starts Program. The New Starts Program is a capital investment program which provides funds for transit capital projects that meet certain criteria. Under New Starts, the federal government could provide up to 80% of capital costs for new transit systems. However, most localities overmatch. SAFETEA-LU created the Small Starts Program, which helps to fund smaller project with a federal share of less than \$75 million. Small starts projects may not total more than \$250 million (APTA, 2005). For FY 2008, \$1.5 billion was appropriated in funding (Boothe, 2007). The Tampa light rail as proposed in this report would be eligible to be considered for New Starts funding because it would be located on a fixed guideway. In addition, funds could be made available from the Surface Transportation Program. The Surface Transportation Program apportions funds based on land miles, vehicle miles traveled, and population. Public transit and transportation enhancement activities were eligible to receive funding from this source.

Of the 25 largest transit agencies in the nation, 23 received funds from dedicated funding sources (Imus, *et al.*, 2007). Taxes and fees are used by many transit agencies to fund new transit service. Local or county sales taxes exist in 33 states and are the most common dedicated funding source. Fifteen of the 25 largest transit systems in the nation use revenue from sales tax to help fund transit. 43% of dedicated funds for these transit systems came from sales tax revenue, amounting to \$4.5 billion in 2003 (Imus, *et al.*, 2007). Often, these sales taxes have been designated specifically for new transit projects. Sales taxes are more politically friendly than other taxes, such as income or business taxes. Local option sales taxes have some benefits and drawbacks. Residents are more supportive to pay extra taxes if the revenues are reinvested into the local area. However, if the tax base is too small, there may be difficulty raising enough funds to pay for the transit service. Sales taxes are relatively stable, but have been declining as people reduce spending during recessions. However, sales taxes are harder for lower income residents to absorb because they often spend a greater proportion of their income on taxable consumption goods. Further, as economies grow, the proportion of goods to services decline. This means that sales taxes are not likely to keep pace with the economy over the long term. Sales taxes will also suffer as more transactions occur online.

Taxes that impact drivers negatively are sometimes considered to be twice as good as taxes that do not. They provide funds for transit service while providing a disincentive for drivers, encouraging more people to use transit. There are many taxes on drivers including fuel taxes, rental car taxes, license/registration taxes, tire tax, weight-based vehicle sales tax, vehicle battery tax, weight-mile truck fees, toll roads, and congestion pricing. Since 2003, the success rate for local referendum to raise funds for transit is 70 percent (Boothe, 2007). Local taxes provide a dedicated revenue source for transit agencies, but agencies may have trouble securing voting approval if the economy is not stable or healthy at the time of vote.

Fifteen states authorized local-options fuel taxes. However, many fuel taxes have already been deemed to use for road maintenance. In Florida, a portion of the fuel tax is put into the State Transportation Trust Fund. The Trust Fund is used for state highway construction, maintenance, and other transportation purposes. A minimum of 15 percent of all receipts deposited into the Trust Fund must be allocated to public transportation projects (US DOT, 2001). Revenues are generally returned to the county in which they were generated. Each county also has a Local Option Fuel Tax Trust Fund, which collects revenue from a local option fuel tax between 1 cent and 11 cents (OHPI, 2001). Revenues from the Local Option Fuel Tax can be used by county and municipal governments for transportation purposes. After revenues from fuel taxes have been dispersed, the remainder goes to the Florida Department of Transportation. A minimum of 10% of fuel sales tax receipts must be allocated to public transit and capital rail projects (OHPI, 2001). Florida ranks near the bottom of the fifty states, with a fuel tax of 14.5 cents per gallon. Only Georgia, New Jersey, Wyoming, and Alaska have lower fuel taxes (Imus, *et al.*, 2007). The average state fuel tax is 20.3 cents per gallon. Thus, Florida, Hillsborough County, or the Tampa area could easily increase their fuel tax and remain under the national average. However, there are several disadvantages to relying on fuel tax revenues. As fuel-efficient cars are becoming a larger share of vehicles on the road, fuel tax revenue will be declining. Further, with gas prices continuing to rise, it will become more difficult to propose and pass increases in fuel taxes.

Taxes on rental cars are used in thirty-eight states to help fund transit (Iman, *et al.*, 2007). Because they are largely paid by out-of-staters, rental car taxes can be more favorable to local voters. Local license or registration taxes have been used in thirty-three states. Twenty states have a version of vehicle license and registration taxes dedicated for transit. As people will continue to pay registration and title fees despite the current economic situation, revenues collected through these fees are highly reliable. Some states are beginning to impose heavier fees based on miles driven or pollutants emitted. The latter of these options is infeasible in Florida, where they do not have emissions testing and standards. However, Florida can follow the likes of New Jersey, who has had surcharges for new car dealers based on fuel efficiency ratings. Since July 2006, new car dealers must pay a 0.4 percent surcharge on the sale or lease of vehicles that fail to meet the 19 miles per gallon EPA fuel efficiency rating (Iman, *et al.*, 2007). Another option is to create pollution fees that are levied against vehicles whose fuel efficiency falls below the state's fleet average. This method allows incentives and revenues to remain strong despite the increase in fuel standards.

In some states, vehicle sales taxes have been based on vehicle weight. As most states already have taxes in place for new vehicles, it would not be difficult to change the tax structure to increase as weight increases. Heavy weight vehicles create more stress to the road network, and in turn cause more maintenance to be needed. By

increasing taxes on heavy weight vehicles and removing some heavy vehicles from the transportation system, more funding for transit could be available. Parking fees encourage transit use while raising funds for transit service. Unfortunately, parking fees have limited revenue-generating ability. Parking taxes can be assessed through a surcharge on parking transactions or as a flat fee for hourly/daily/monthly rates (Iman, *et al.*, 2007).

Public-private partnerships have been an increasingly popular way of securing funding for new transit systems, especially light rail projects. Impact fees on developers or local real-estate transfer fees may also be levied to raise funds. By 2000, impact fees were used by 59% of local communities over 25,000 (GOA, 2000). Impact fees are typically used to help alleviate the burdens that new developments have on the road system due to the increase in traffic flow and the new infrastructure requirements. Specific transit impact fees have been used in the San Francisco area to charge developers of office space to pay for the burden of their developments on the transit system (TCRP, 1998). This type of impact fee could be used to generate operating funds once the light rail system is completed. Fee exemption can be used to encourage smarter growth near public transit. Large developments could be made to a state fund for public transportation to offset the burden they cause on the transportation system. When using impact fees, jurisdictions must be aware of legal consequences and ensure that fees are written with appropriate language and are backed by supporting analyses (TCRP, 1998).

Tax increment financing (TIF) has been used to fund transit projects. As infrastructure investments are built, property values around that investment increase. TIF work by dedicating a percentage the taxes from the increase in property values to a certain project or fund. A business improvement district (BID) is another way to use private investment to fund a dedicate project, such as new transit service. TIF is different than BIDs because BIDs obtain money by an additional tax that property owners in the area agree to pay. TIFs traditionally generate more funds than BIDs. However, with improvement of BID programs, they may also be able to generate funds for transit operation. To relate station development and transit service development to a better extent, private developers can make up-front capital contribution for the right to serve as the master developer for the right to develop at the proposed stations. Policy changes by FTA in the late 1990s made joint development more feasible and now property bought with federal monies can be used for non-transit purposes (TCRP, 1998).

To meet the new “green” programs encourage by the Planning Commission and to raise funds, the new light rail system can follow the leadership of the Regional Transportation District in Denver by creating an Eco Pass Program. The Eco Pass Program works by having employers provide a specified dollar amount per month pretax commuting benefit to employees. This benefit is tax deductible to the employer under the deferral transit benefit program. The Eco Pass provides the employee with an unlimited ride transit pass. In RTD’s implementation, pricing was based on the business’s number of employees and location. Studies during the 1990s showed that the Eco Pas increased ridership, decreased singly occupancy vehicle trips, and improve the region’s quality of life. After the first seven years of the program, more than 1,100 companies and 32,000 employees were using the program (TCRP, 1998).

Partnerships with the community have also proved to be successful for a number of transit agencies. Issuing passes to school aged children and charging the school district a fee for each pass have been used in Washington. By transferring some riders from the school district’s transportation system to the City’s transportation system reduces overall cost to the school district. In the Pullman, Washington example, the payment from the school district totaled almost \$40,000 for the 1996-1997 school year, or 3% of the transit system’s operating budget (TCRP, 1998). Partnerships with the University of South Florida can be used as a local match for federal assistance. The system may qualify for matching funds if USF provides funding to the system out of fees charged to its students. The funding from the University could be to provide discounted student ticket or to increase transit service or provided discounts to fans on University game days. Some communities have also used Transit and Shop programs to promote ridership and raise funds. The program works by providing free transit vouchers to customers who provide receipts with a qualifying purchase amount from valid merchants, e.g. from malls or other large shopping centers. The transit provider then collects the revenues from the participating merchants. This program has been used in Iowa City and was successful at providing revenues of \$15,000, 0.5 percent of Iowa City Transit’s operating budget. Thus, community partnerships can provide a revenue source for the transit agency, can provide a match for federal grant funds, and can provide a flexible travel options for the transportation disadvantaged.

Increases in fare to meet the cost of providing service are not encouraged. Fare increases price out the most needy users of transit, while discouraging choice riders from using the service. Therefore, transit ridership decreases, reducing the potential increase in farebox recovery.

CHAPTER SIX

PLANNING & ZONING

To secure funding from the federal government, a submitted transit plan must have transit-supportive land use provisions. Zoning provisions are the most commonly used techniques to carry out a community's priorities (Snohomish County, 1989). Zoning also provides one of the effective ways to change the fabric of the built environment and to secure long-term transit ridership.

Snohomish County, Washington (1989) listed general provisions a municipality can set for zoning districts to increase transit usage:

- Include definitions of public transportation modes and facilities
- Establish zoning ordinance measures as the threshold requirement for the application of transit-compatible standards to redevelopment, major additions, and changes to existing land uses and buildings
- Include a provision to establish a basis for measuring the distance of pedestrian trips
- Permit compatible home occupations in all residential zoning districts and defined them by the zoning ordinance
- Determine with the local transit operator a procedure to include the transit operator in the review of commercial, residential, industrial, and office applications

Florida also has standards for creating Multi-modal Transportation Districts (MMTD). MMTD were authorized in 1999 by the amendment of Chapter 163 of the Florida Statutes, commonly known as the Growth Management Act (Williams, *et al.*, 2004). The MMTD was established to provide alternative approaches to concurrency determinations in the Growth Management Act. Instead of setting standards in a local comprehensive plan based on automobile usage, the MMTD allows measures to be based on all available modes of transportation.

In late 2007, the Hillsborough County City-County Planning Commission “adopted” a green strategy regarding energy conservation, sustainability, and green buildings. The Planning Commission voted to recommend that the local jurisdictions in the County develop recommendations to become more energy efficient and present them to the Commission. The recommendations will be used in conjunction with the Governor's targets for reducing greenhouse gas emissions by 10% by 2012 (Hillsborough County City-County Planning Commission, 2007). While the Commission is moving in the correct direction in terms of environmental concerns, their planning policies do not necessarily reflect that change.

In order to improve the quality of life for the region, increase mobility, and increase environmental sustainability, Tampa needs to create new development patterns. Therefore, a more permanent transit infrastructure needs to be developed. Tampa must make adapt itself to have regional planning at heart with detailed attention to local area and site planning. Achieving a larger objective, such as open-space preservation, affordable housing, and improved air quality, is the key to adapting a city. However, extra tools beyond transit are needed to support these objectives. These can vary from containment policies such as greenbelts and growth boundaries to density bonuses and transferrable development rights to parking and pricing strategies.

Below are recommendations for improving planning policies to not only promote environmentally sustainable strategies, but also to increase multimodal transportation, including transit usage, and improve the built environment:

1. Promote the usage of Multi-modal Transportation Districts
2. Encourage Transit Oriented Developments
3. Increase residential densities
4. Reduce parking, increase parking fees, and offer parking cash-out
5. Encourage public transit-compatible in-fill development
6. Locate employment centers near public transportation

7. Encourage developments to provide a mixture a housing types

RECOMMENDED CHANGES

Recommendation 1: Promote the usage of Multi-modal Transportation Districts

MMTD allow municipalities to have greater flexibility with concurrency standards that leading to funding. Through MMTD legislation, developments can achieve the intensity and type of development that supports mass transit. In order to implement MMTD designation, a municipality needs to amend the local government comprehensive plan and the future land use map. Then, the proposed MMTD must be reviewed and approved by the Department of Community Affairs and the Florida Department of Transportation. To be approved, the following criteria must be met (Williams, *et al.*, 2004):

- A complementary mix and range of land uses
- An interconnected network of streets walking and bicycling, with traffic calming where desirable
- Appropriate densities and intensities of use within walking distance of transit stops
- Daily activities within walking distance of residences, allowing independence to persons who do not drive
- Public uses, streets, and squares that are safe, comfortable, and attractive for the pedestrian, with adjoining building open to the street and with parking not interfering with pedestrian, transit, automobile, and truck travel modes

The MMTD process should include community outreach and community profiling, which will help to develop a long-term plan. The community profile can help to identify where improvements should be made and create strategies to reduce or avoid potential adverse impacts of implementing the MMTD.

MMTDs may be necessary to the implementation and success of the other recommendations in this section. Further, by designating an area as a Multi-modal Transportation District, the locality's comment to positively changing the future of the area is concreted.

Recommendation 2: Promote the usage of Multi-modal Transportation Districts

Encourage Transit Oriented Developments

Transit Oriented Developments (TODs) are dense, mixed-use developments planned and built around transit stops. TODs are aimed at providing residences, retail, and office space within a ½ mile walking distance of a transit stop. TODs have been popular in Portland, Oregon and have aided in the success of the Portland MAX light rail system. TODs increase transit use by providing large population bases and attractions at each transit stop. The benefits of TODs include: increased transit ridership, dispersal of trip distribution over time, increased available travel mode choices, reduction of vehicle miles traveled, reduction of air pollution and energy consumption, preservation of open space, enhancement of public safety, encouragement of economic development, increased household disposable income, promotion of housing affordability, and reduction of municipality expenditure on infrastructure (Parker, *et al.*, 2002; Cervero, *et al.*, 2004; Wells and Renner, 2004; Lin and Shin, 2008). Cervero and Kockelman (1997) organized development strategies of TODs into three dimensions: enhancing development density to increase transit ridership; diversifying land use to improve convenience for public transportation passenger; and creating pedestrian-friendly sidewalks and transfer systems to increase the utilization of mass-transit systems. Literature has shown positive associations between TODs and transit system use in San Francisco and Arlington, VA (Cervero, *et al.*, 2004). According to research in Portland, residents in mixed-use neighborhoods with good

transit access have been shown to use automobiles for 58 percent of trips, while suburban households use automobiles for 87 percent of trips. Research in California has shown that residents of TODs are 5 times more likely to use transit and employees in TODs are 3.5 times more likely to use transit than the remainder of the region (Reconnecting America, 2007).

TODs can be encouraged through a number of financing strategies such as tax increment financing and density bonuses. In addition, if TODs are developed in conjunction with planning new transit lines, they can be leveraged to help finance the construction of the transit line.

As not all developments may currently have transit service, developers should be required to include public transportation compatible designs into their projects for future service extensions. This not only helps the overall design of the city, but will make future transit planning easier for the local planning authority. In addition, mixed land uses reduce the number of auto trips, encouraging walking and bicycling.

Recommendation 3: Increase residential densities

Ridership on transit increases as residential densities increase along transit corridors. Kuby, *et al.* (2004) found that for every 100 residents within walking distance to a light rail station, there is an additional 9.2 boardings. Many of the locations around the proposed light rail stations have the ability to increase residential densities. Current projections indicate that at the current rate of development, the City of Tampa can accommodate 41,540 new residents, which the Planning Commission estimates to not be sufficient enough to accommodate project population growth through 2025 (Hillsborough County City-County Planning Commission, 2008). Therefore, increasing residential densities is way approach to balance development and sustainability.

Recommendation 4: Reduce parking, increase parking fees, and parking cash-out

Parking management programs such as parking reduction, increasing parking fees, and parking cash-out encourage transit usage. Parking should have maximum requirements.

Most parking demand studies focus on the busiest days of the year in terms of demand. However, for the remainder of the year, minimum parking requirements provide an abundance of unused space. Further, by providing ample parking spaces, there is no discouragement to driving, decreasing transit usage and reinforcing reliance on automobiles. Minimum parking requirements also increase land and material costs during construction.

TABLE 9 AVERAGE PARKING CASHOUT PARKING IMPACTS

MEASURE	AVERAGE VALUE		
	BEFORE	AFTER	CHANGE
Drive Alone Mode Share	76.8%	65.3%	-11.5%-Pts.
Carpool Mode Share	12.9%	20.0%	+7.1%-Pts.
Transit Mode Share	5.8%	8.3%	+2.5%-Pts.
Walk Mode Share	3.1%	4.6%	+1.5%-Pts.
Bicycle Mode Share	1.1%	1.4%	+0.2%-Pts.
Annual Vehicle Trips/Employee	379	335	-11%
Annual VMT/Employee	5348	4697	-12%

Taken from TCRP 95c13, 2003.

Parking “cashout” is a modest subsidy reform in which employees who are given free parking at work can in essence return the space and not use it for the equivalent value in cash. Cashouts have universal public support (Lewis, 1998). As more parking in large lots are traded for cashouts, the land can then be used for redevelopment. Increasing parking changes and offering cashouts have been shown to have strong made shifts away from single-occupancy driving (Wilson and Shoup, 1990; Wilson, *et al.*, 1989). This is

evident in the success of BART, where parking costs in downtown San Francisco, Oakland, and Berkeley are very high and encourage people to use transit instead (Lewis, 1998). Table 9 shows the effects of parking cashouts from a study of eight Southern California cases. While transit modal share only increases 2.5 percentage points, drive alone modal share decreases by 11.5 percentage points.

Recommendation 5: Encourage transit-compatible infill development

Transit works best in developed, urban environments. It is logical to assume that not all properties along the proposed light rail transit corridors are necessarily developed. Developing these infill locations should be encouraged by the City to densify transit corridors and preserve periphery greenfields. Infill development is a sound economic development strategy because it provides efficient use of existing services and facilities, while enhancing the tax base. Infill development can be promoted through grants, lowering impact fees, streamlining permitting, and offering tax abatement.

Recommendation 6: Locate employment centers near public transportation

Large employment centers should be required to be located near public transit facilities to increase the amount of commuters who are able to use transit. In conjunction with business subsidized transit passes, transit ridership will increase while reducing roadway congestion.

As recently as the 1980s, mass transit was able to capture over half of work trips in cities like Chicago, Boston, New York, and San Francisco (US DOT, 1984). Literature indicates that LRT ridership can increase exponentially with total CBD employment and employment density (Parsons Brinckerhoff Quade & Douglas Inc., 1996). Kuby, *et al.* (2004) found that for every 100 employees within walking distance of a light rail station, there is an increase of 2.3 passengers. By locating employment nearer to public transportation, Tampa will be able to increase its commuter modal share. However, free parking will still be impediment to achieving high commuter ridership. Negligible rail usage for suburban office parks beyond the station area has been found when free parking is offered (Cervero, 1993).

Recommendation 7: Encourage developments to provide a mixture of housing

Affordable housing and housing equality are two pressing issues in urban areas. Providing a mixture of housing types into developments not only increases affordability, but desegregates the community. Housing mixtures also allow more renters into choice locations. Renters have the added benefit of increasing transit ridership. For every 1 percentage point increase in the percentage of households that rent near a light rail station, there is an additional 6.24 boardings (Kuby, *et al.*, 2004).

CHAPTER SEVEN

CONCLUSION

This report provides a new alternative to Tampa's increasing transportation problems. The funding approaches compiled in this document serve as a starting point for a long-term financial solution. Adapting the built environment through the methods described earlier can help increase ridership while accommodating future growth.

A comprehensive light rail system for Tampa would provide north-south mobility, east-west connections for the northern part of the city, provide complete downtown connectivity, and tie into local, regional, and national transportation systems. The system would link residential communities to large employment areas, regional hospitals, malls, cultural activities, and sports venues. The system proposed in this document has not only been designed for the commuter, but can be used for nightlife and weekend activities.

To improve the mobility of the region and to increase bus ridership, it is recommended that HART redesign their bus system to supplement the light rail system. For each additional bus route intersecting with a light rail station improves ridership by 123 weekday boardings (Kuby, *et al.*, 2004). Actual timing of the phases should be examined to determine the bus time frame to implement the bus redesign. If the spacing between the two phases is large enough, then a bus redesign could be implemented twice. If there not enough time difference between the phases, then the bus redesign should be delayed until the entire light rail system is completed. The delay is necessary as not to confuse riders with too many route modifications.

The TECO Streetcar system has already realized a 1970.39% return on investment (Reconnecting America, 2007). The proposed system in this plan offers more a chance for return on investment because it is more extensive, connects more destinations, and because, thanks to the streetcar system, Tampa has experience in transit adjacent and transit oriented developments. Despite the relatively high cost of the proposed system, the effects the system on the area's built environment, environmental sustainability, and quality of life provide ample enough return on investment to make the project worth the cost.

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APPENDIX

FIGURE 7 POPULATIONS OVER 65 YEARS OF AGE

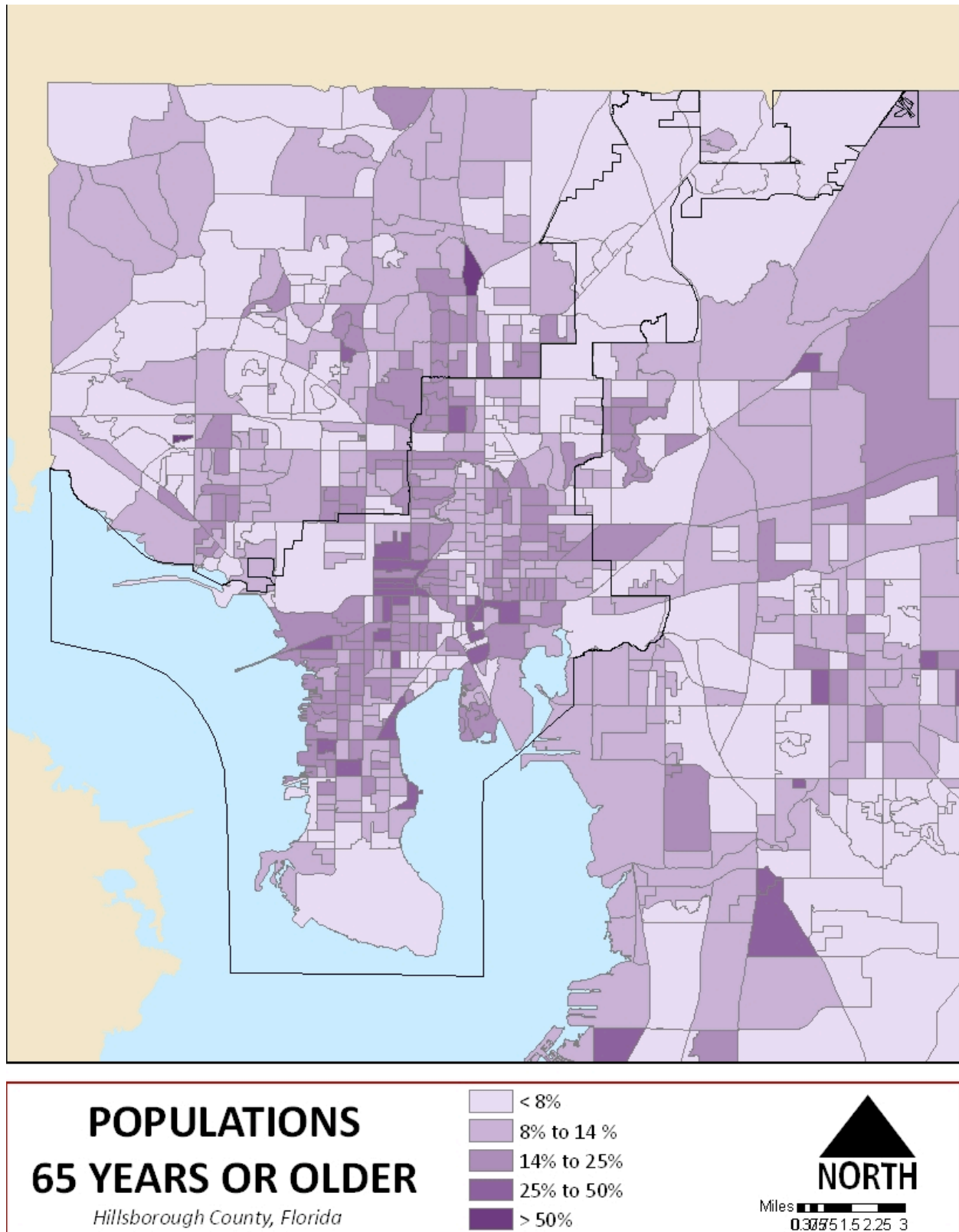


FIGURE 8 CHOICE RIDER POPULATIONS

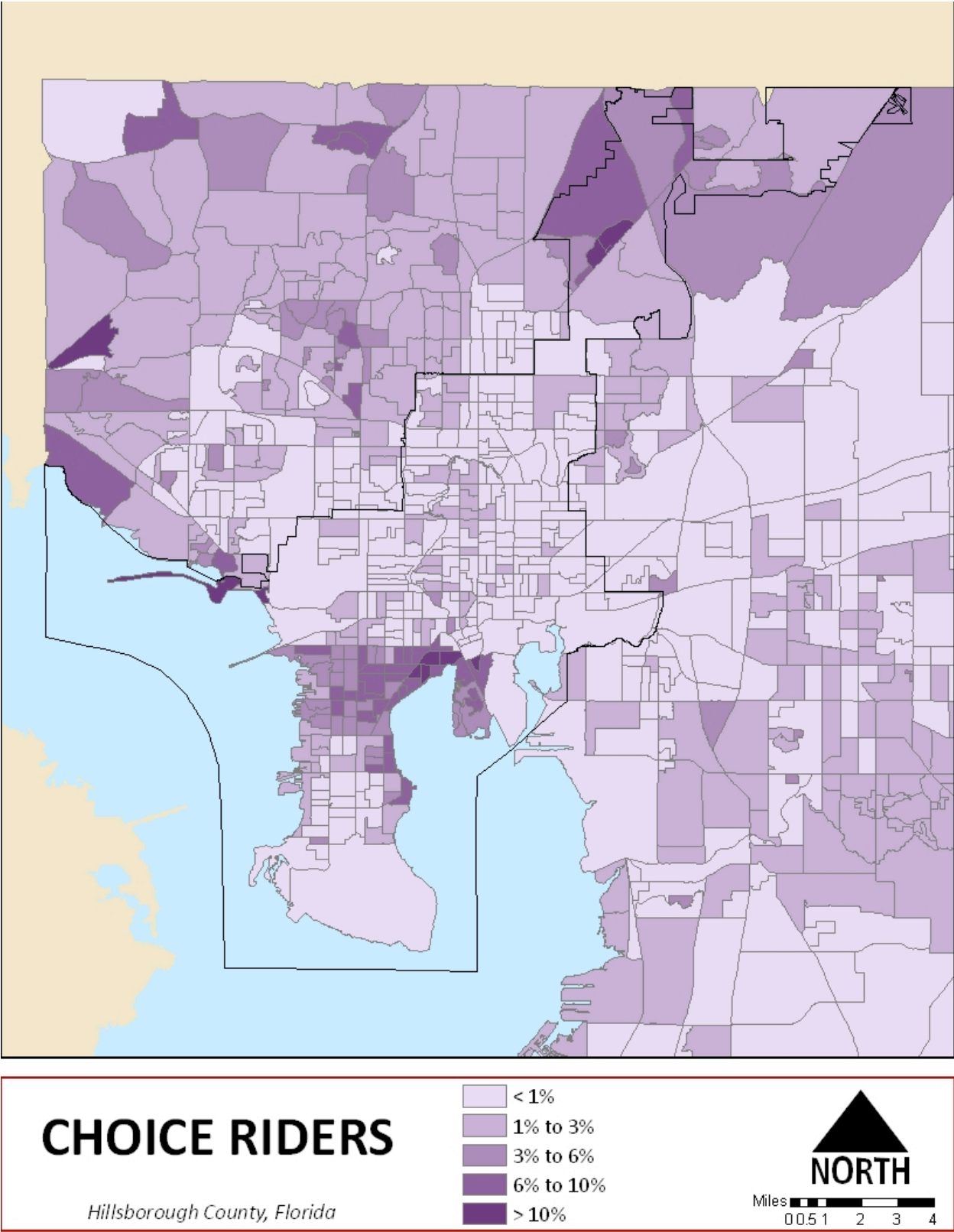


FIGURE 9 TRANSIT SUPPORTIVE EMPLOYMENT DENSITIES

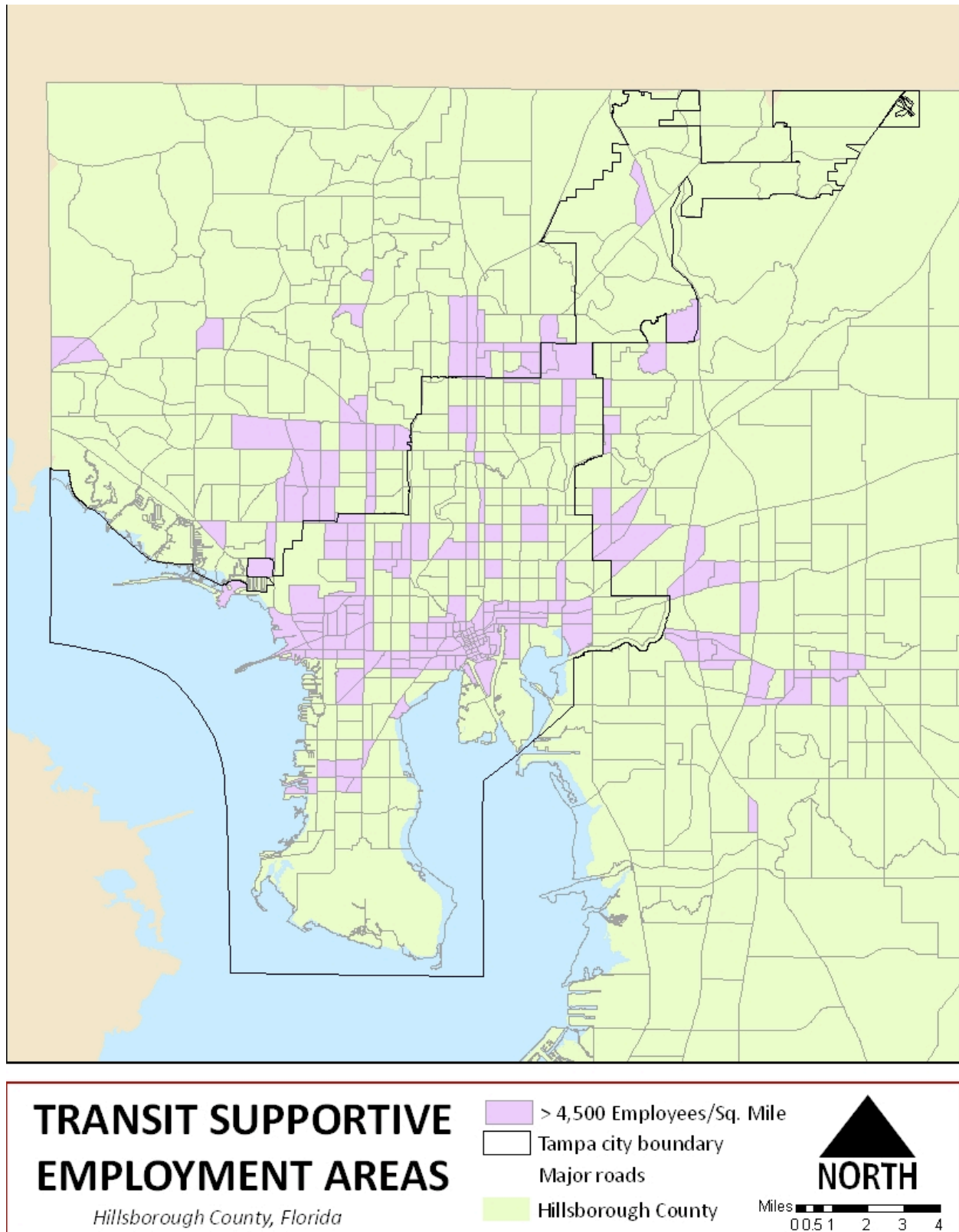


FIGURE 10 TRANSPORTATION SUPPORTIVE POPULATION DENSITIES

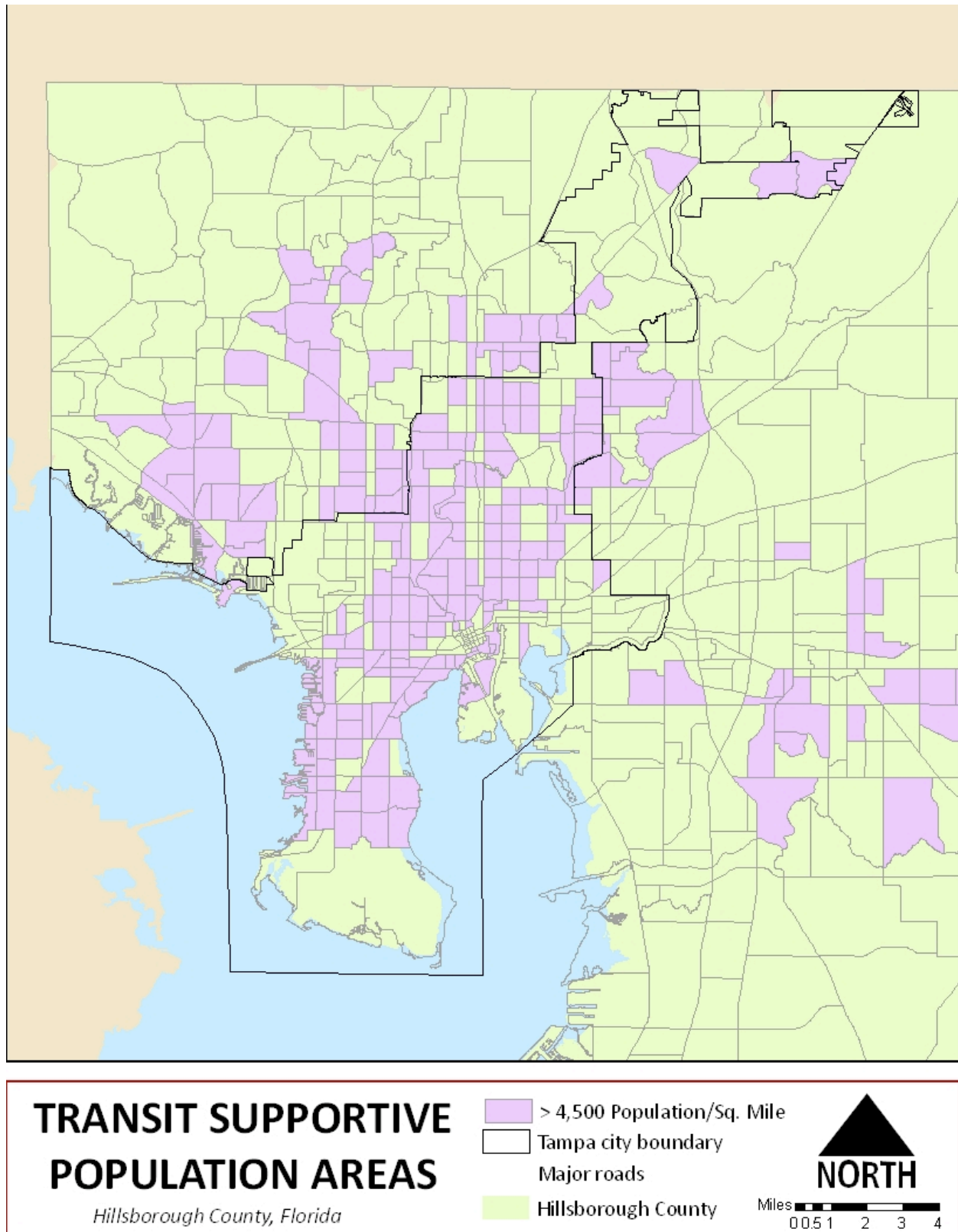


FIGURE 11 POVERTY

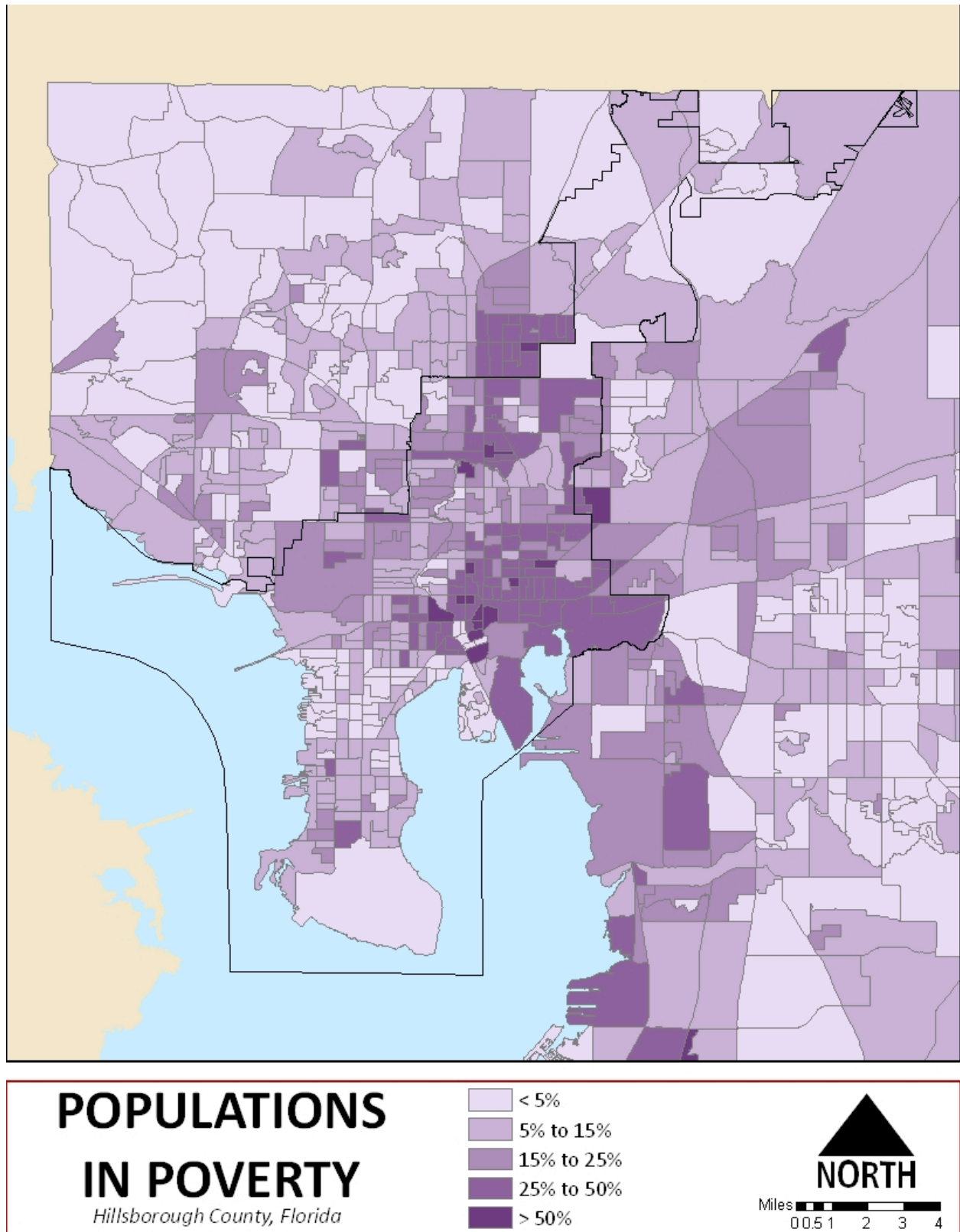
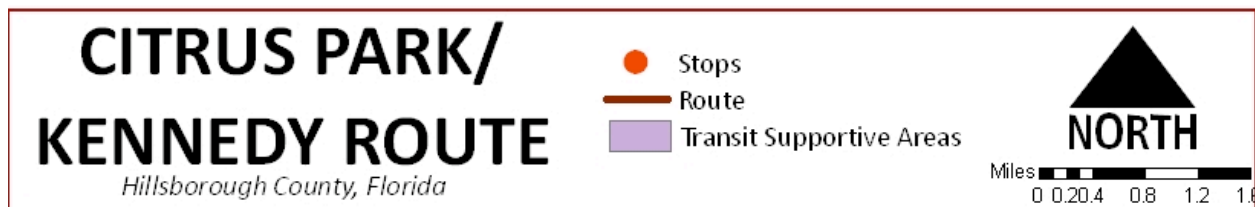
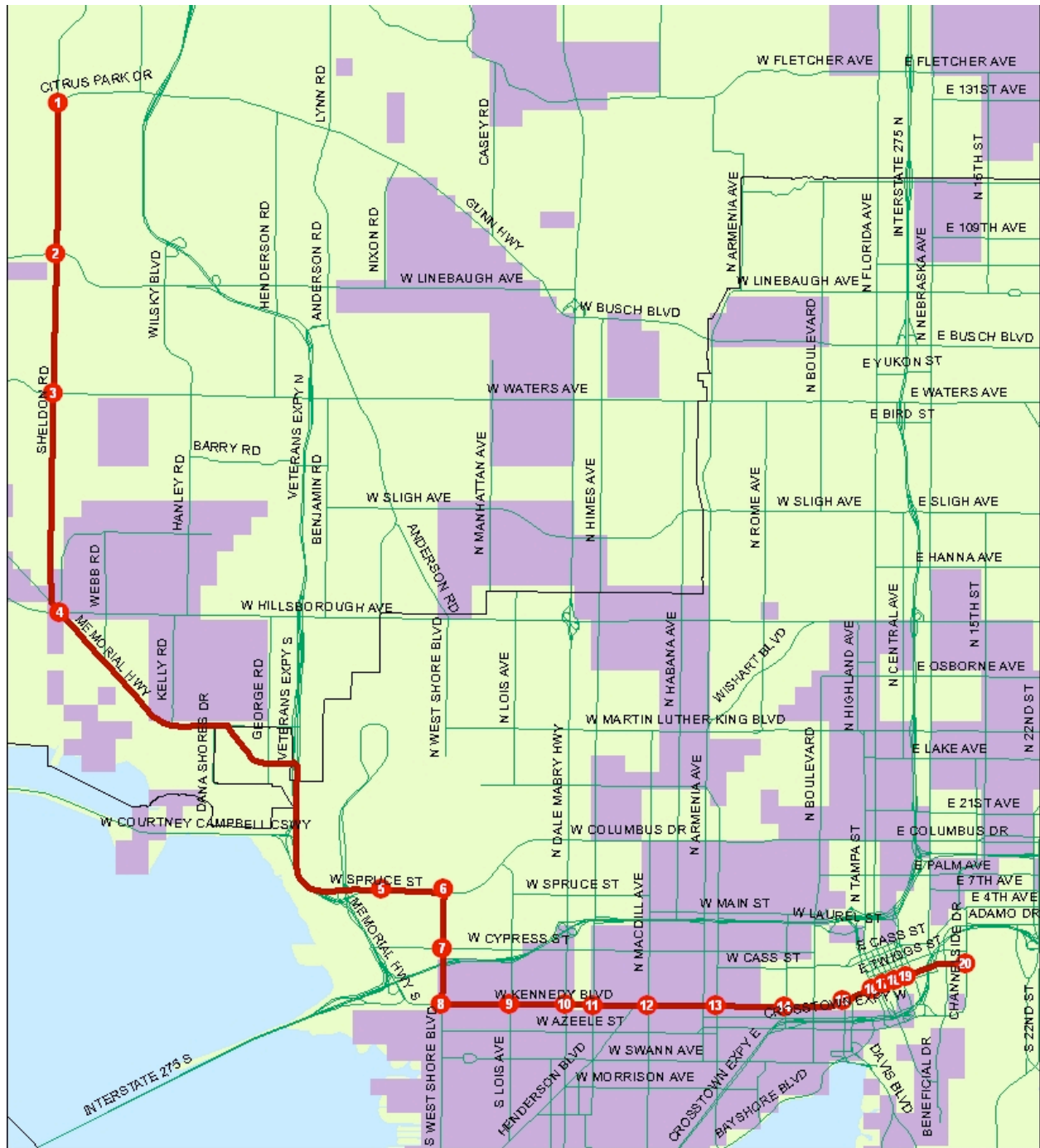


FIGURE 12 CITRUS PARK TO KENNEDY ROUTE



The map displays the proposed TART route through Tampa, Florida. The route is indicated by a red line with numbered stops. Key features include:

- Route 1:** Starts at the top of the map, near W Bearss Ave, and runs south through the city center.
- Stops 1-18:** A vertical line of stops running from the top to the bottom of the map, passing through major thoroughfares like W Fletcher Ave, W Linebaugh Ave, W Waters Ave, W Sligh Ave, W Hillsborough Ave, W Tampa Bay Blvd, W Columbus Dr, W Spruce St, W Express St, W Kennedy Blvd, W Azelle St, W Swann Ave, and W El Prado Blvd.
- Stops 19-24:** A branch route starting from stop 18, heading east along the waterfront and through the downtown area, passing through stops 19, 20, 21, 22, 23, and 24.
- Geographic Features:** The map shows the Gulf of Mexico to the west, the Alafia River to the east, and various highways including Interstate 275 and Interstate 4.
- Other Roads:** Numerous local roads are labeled, including W Bearss Ave, W Fletcher Ave, W Linebaugh Ave, W Waters Ave, W Sligh Ave, W Hillsborough Ave, W Tampa Bay Blvd, W Columbus Dr, W Spruce St, W Express St, W Kennedy Blvd, W Azelle St, W Swann Ave, W El Prado Blvd, W Busch Blvd, W Sligh Ave, W Hanna Ave, W Osbourne Ave, W Lake Ave, W 21st Ave, W Columbus Dr, W Palm Ave, W 7th Ave, W Broadway Ave, W Adams Dr, W Maybell Dr, W Causeway Blvd, W 50th St, W 40th St, W 34th St, W 30th St, W 22nd St, W 15th St, W 10th St, W 8th St, W 6th St, W 4th St, W 2nd St, W 1st St, W 0th St, W -1st St, W -2nd St, W -3rd St, W -4th St, W -5th St, W -6th St, W -7th St, W -8th St, W -9th St, W -10th St, W -11th St, W -12th St, W -13th St, W -14th St, W -15th St, W -16th St, W -17th St, W -18th St, W -19th St, W -20th St, W -21st St, W -22nd St, W -23rd St, W -24th St, W -25th St, W -26th St, W -27th St, W -28th St, W -29th St, W -30th St, W -31st St, W -32nd St, W -33rd St, W -34th St, W -35th St, W -36th St, W -37th St, W -38th St, W -39th St, W -40th St, W -41st St, W -42nd St, W -43rd St, W -44th St, W -45th St, W -46th St, W -47th St, W -48th St, W -49th St, W -50th St, W -51st St, W -52nd St, W -53rd St, W -54th St, W -55th St, W -56th St, W -57th St, W -58th St, W -59th St, W -60th St, W -61st St, W -62nd St, W -63rd St, W -64th St, W -65th St, W -66th St, W -67th St, W -68th St, W -69th St, W -70th St, W -71st St, W -72nd St, W -73rd St, W -74th St, W -75th St, W -76th St, W -77th St, W -78th St, W -79th St, W -80th St, W -81st St, W -82nd St, W -83rd St, W -84th St, W -85th St, W -86th St, W -87th St, W -88th St, W -89th St, W -90th St, W -91st St, W -92nd St, W -93rd St, W -94th St, W -95th St, W -96th St, W -97th St, W -98th St, W -99th St, W -100th St.



DOWNTOWN LOOP
Hillsborough County, Florida

Legend:
 ● Stops
 — Route
 ■ Transit Supportive Areas

Scale: 0 0.04 0.08 0.16 0.24 Miles

North Arrow: NORTH

The map displays the proposed Downtown Loop route in Hillsborough County, Florida. The route is marked with a red line and numbered stops 1 through 11. The route starts at Stop 1 (E Tyler St), proceeds north to Stop 2 (E Cass St), then east to Stop 3 (E Polk St), and continues through a grid of streets including E Zack St, E Twiggs St, E Marion St, E Kennedy Blvd, E Jackson St, E Brorein St, and S Franklun St. It then turns south along S Harbor Island Blvd to Stop 4, continues to Stop 5 (S Ashley Dr), and proceeds south to Stop 6 (W Kennedy Blvd). From Stop 6, the route turns west along W Cleveland St, W Platt St, and W Bay St, then turns south along S Hyde Park Ave, W De Leon St, and Bayshore Blvd. It continues south to Stop 7 (Davis Hwy), then turns east along Davis Hwy to Stop 8 (Davis Hwy), and finally turns south along Beneficial Dr to Stop 9 (Beneficial Dr). The route then turns east along S Meridian Ave to Stop 10 (S Meridian Ave), and finally turns north along S Meridian Ave to Stop 11 (S Meridian Ave). The map also shows major roads like Interstate 275, N Nebraska Ave, N Meridian Ave, and S Meridian Ave. Transit supportive areas are indicated by purple shaded regions.

FIGURE 15 NORTHERN CONNECTOR ROUTE

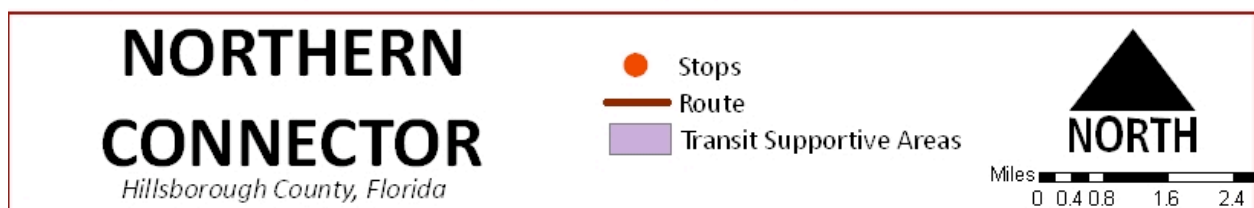
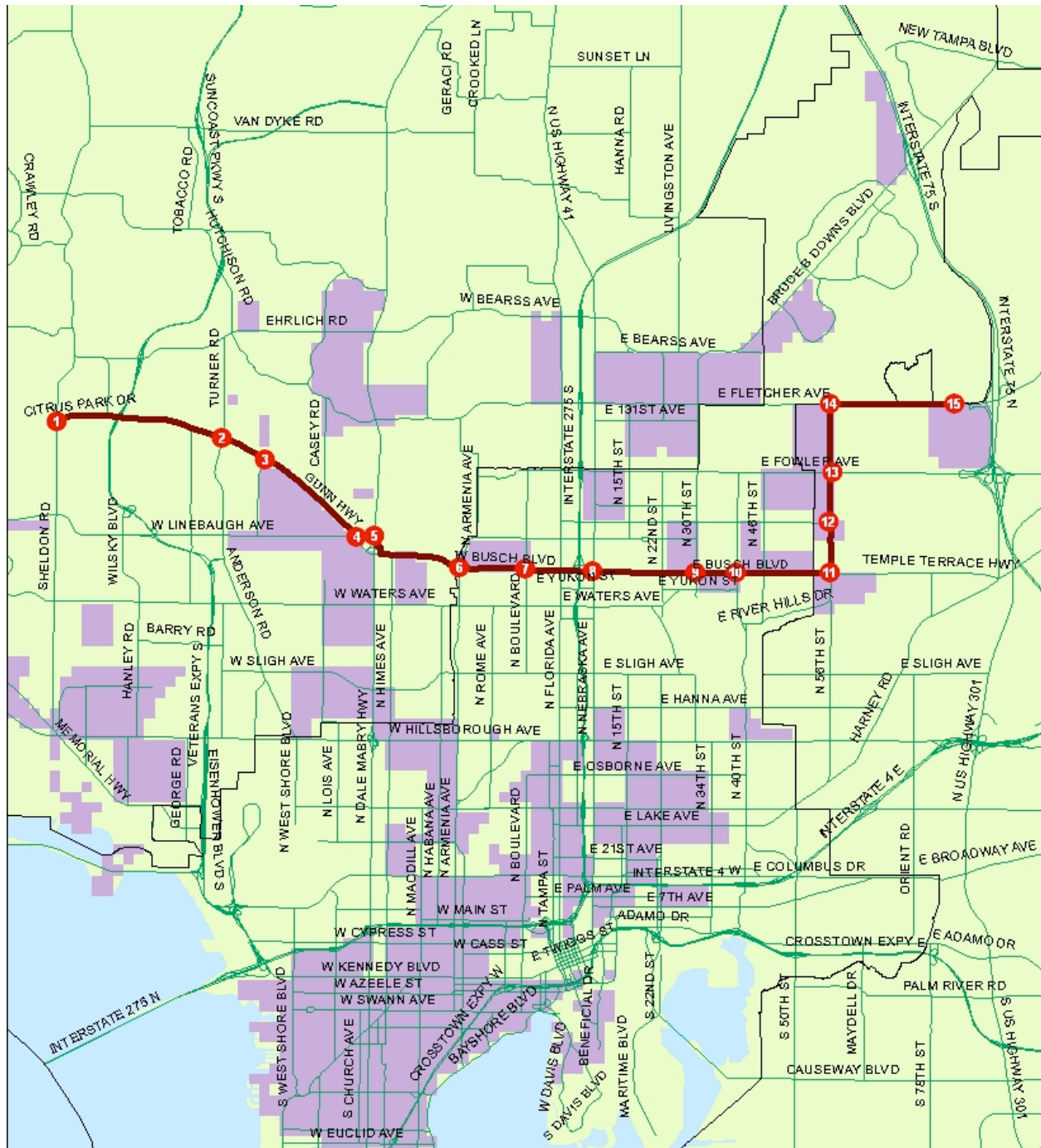


FIGURE 16 NEW TAMPA TO DOWNTOWN ROUTE

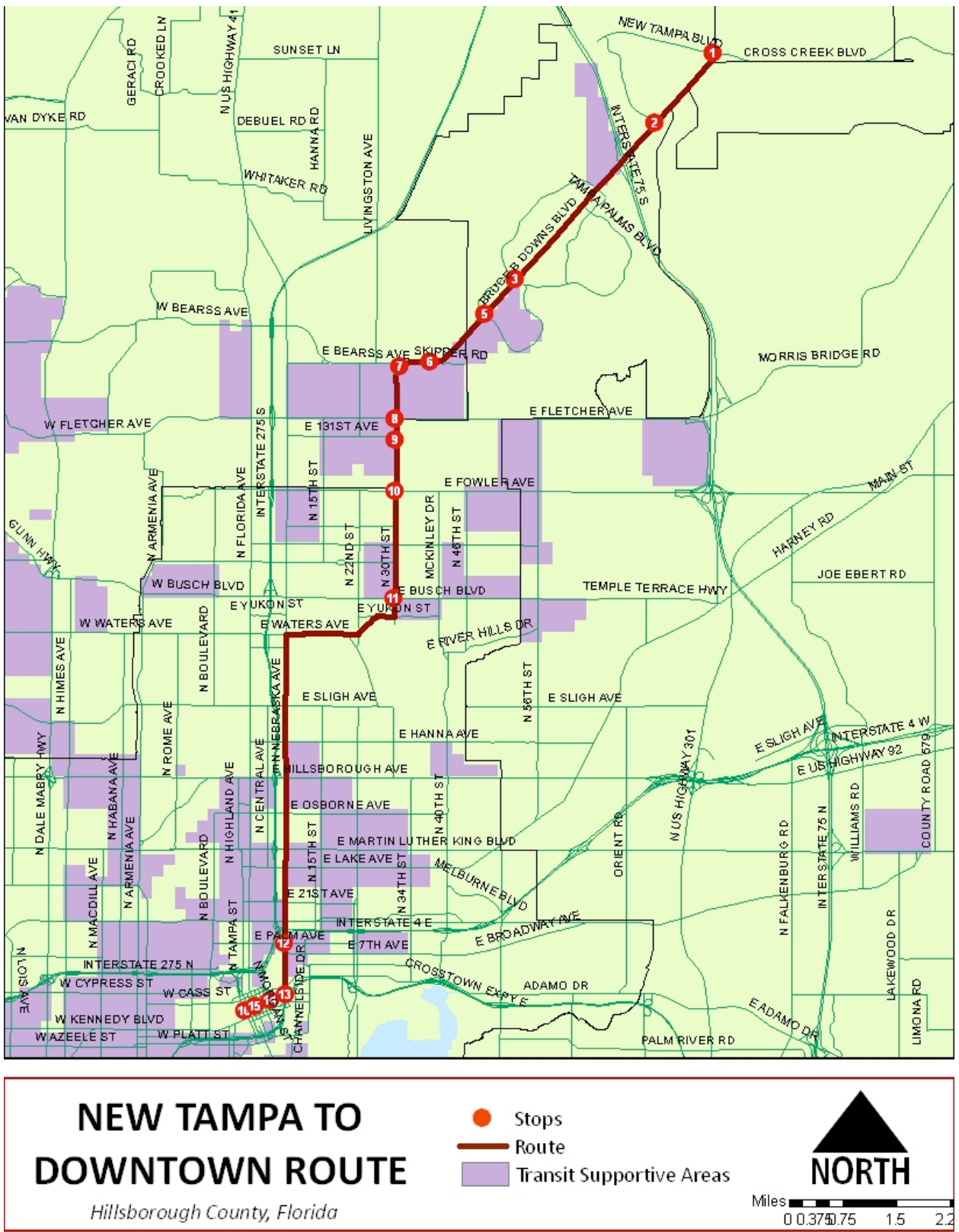


FIGURE 17 USF TO YBOR CITY ROUTE

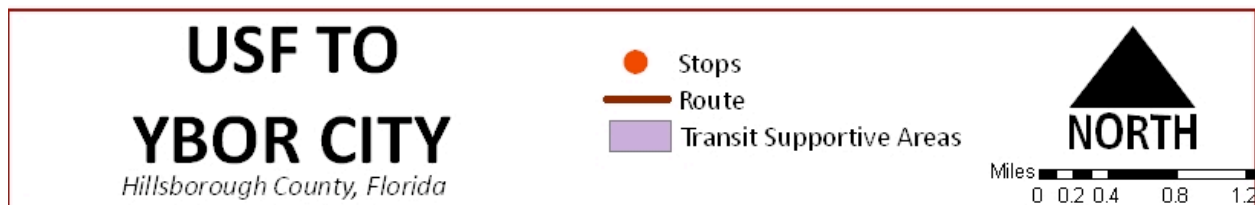
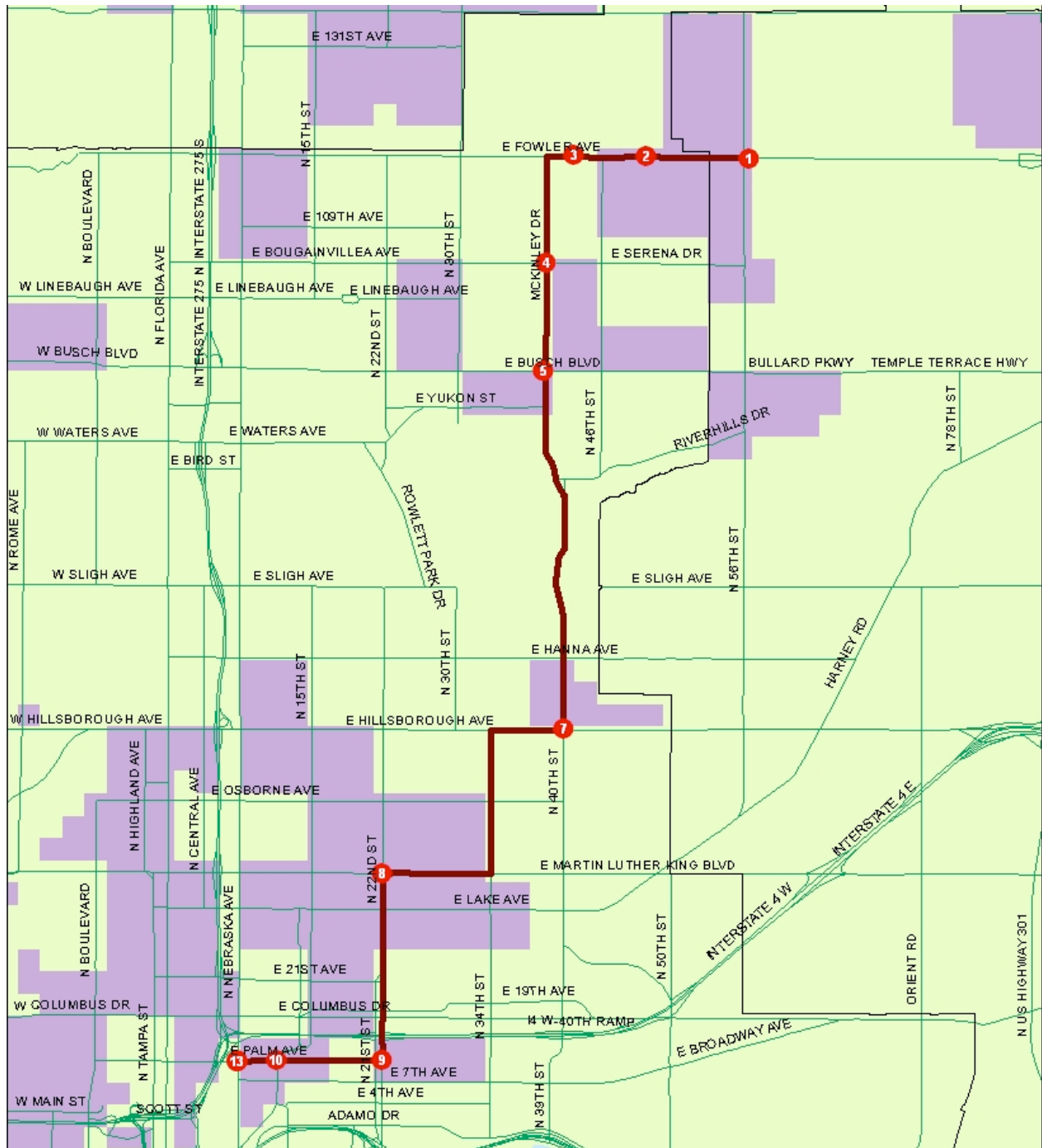


FIGURE 18 TRANSIT DEPENDANT POPULATIONS

